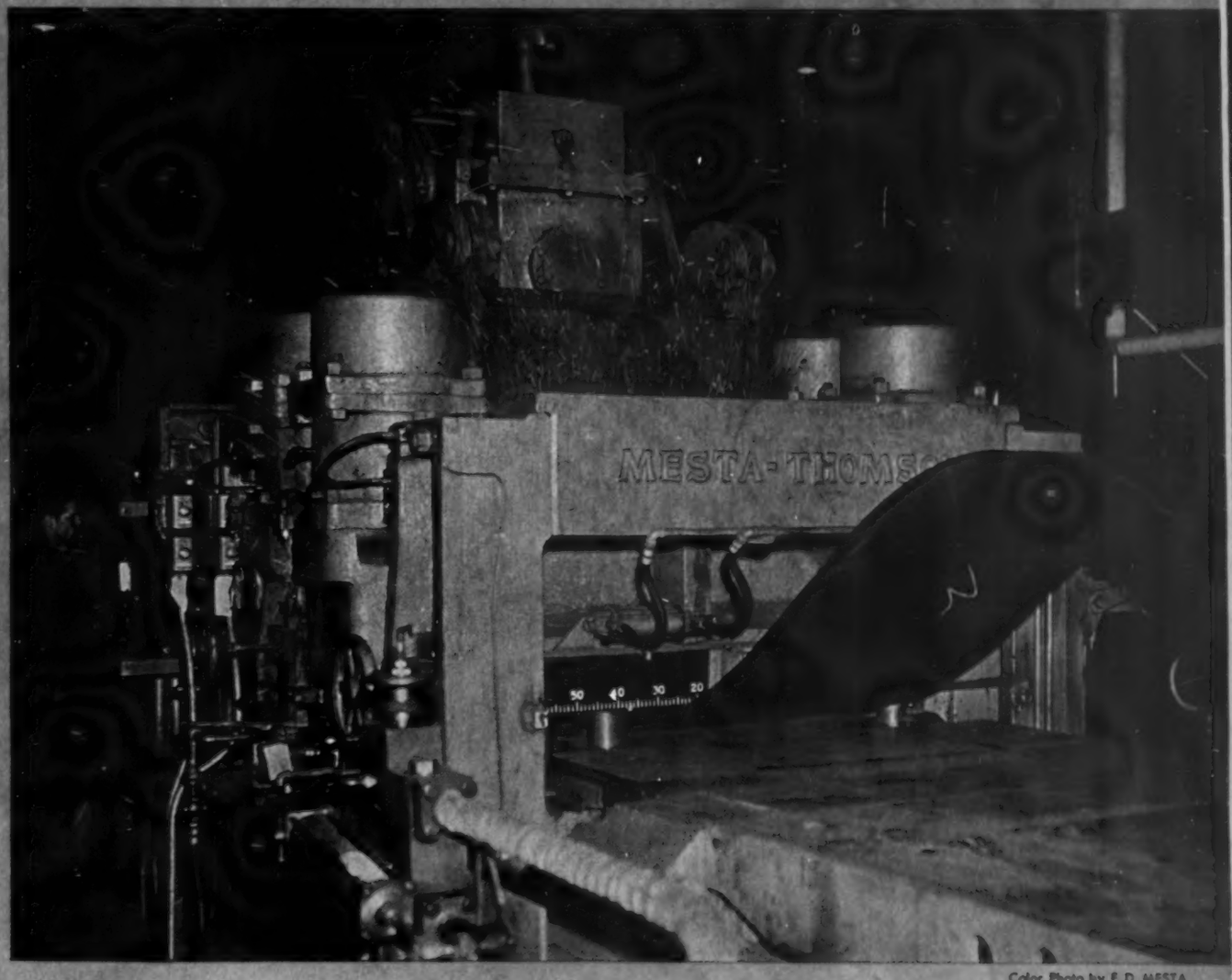
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JUNE, 1948

DETROIT

Increase Cold Mill Production with
MESTA-THOMSON Flash Welders



Color Photo by E. D. MESTA

42" Mesta-Thomson Flash Welder in a
Mesta High-Speed Continuous Pickling Line installed at
Jones & Laughlin Steel Corporation, Aliquippa Works.

MESTA MACHINE COMPANY . . . PITTSBURGH, PA.

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

for the First Time HEAT is LICKED!

In the new line of Cutler-Hammer safety switches, the tables are turned. For here is a switch mechanism designed to withstand *safely* any degree of heat that can be expected from correctly selected fuses.

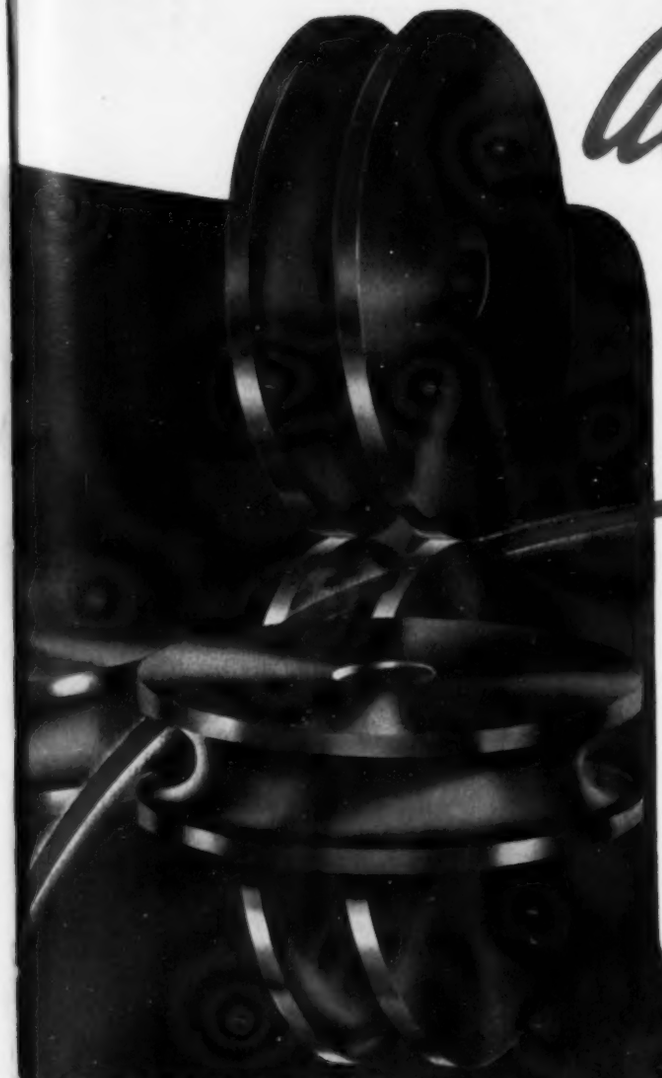
So dependable in performance, so easy to install, so convenient to operate, so attractive in appearance are these Cutler-Hammer safety switches, alert contractors everywhere are featuring them, recommended by Cutler-Hammer wholesalers from coast to coast. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin.

CUTLER-HAMMER
SAFETY SWITCHES
C-H

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress March 3, 1879. $7.50 per year in United States, $8.25 Canada, $10.00 foreign countries. Volume 25, No. 6.

Aetna-Standard's

NEW continuous butt weld pipe mill with 10 STANDS



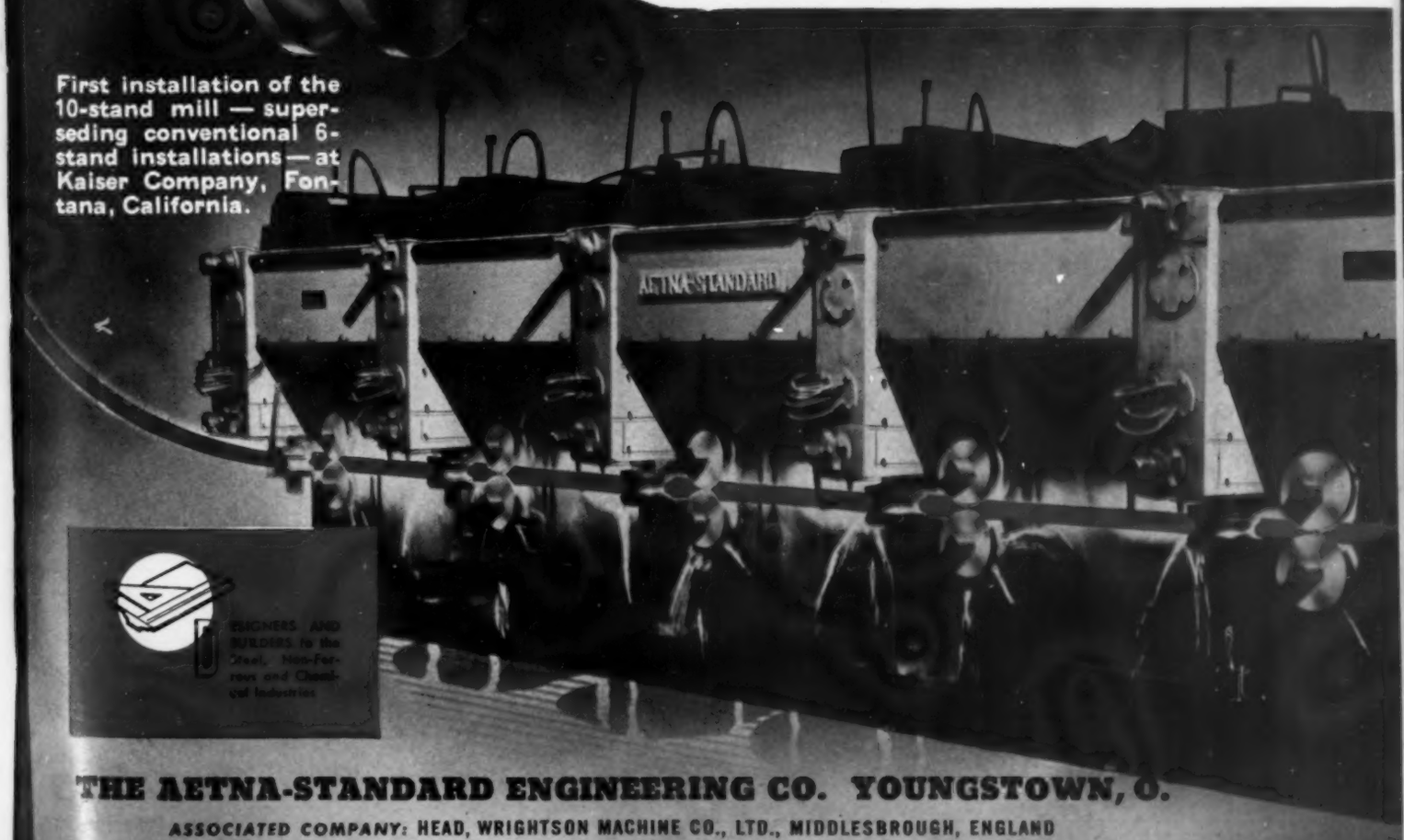
The 10-STAND mill produces these three distinct production and cost advantages over the conventional 6-stand mill:

1 *Greater Production* — An increased output, of as much as 50%, is achieved on some sizes of pipe. Wider skelp is processed — reduced and elongated to desired pipe size.

2 *Higher Furnace Efficiency* — Since a wider skelp is used, furnace efficiency is much increased. Increased production is effected without increase of skelp speed through the furnace.

3 *Better Quality* — Results have demonstrated that the increased reduction tends to increase the quality of the weld.

First installation of the 10-stand mill — superseding conventional 6-stand installations — at Kaiser Company, Fontana, California.



ENGINEERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries

THE AETNA-STANDARD ENGINEERING CO. YOUNGSTOWN, O.

ASSOCIATED COMPANY: HEAD, WRIGHTSON MACHINE CO., LTD., MIDDLESBROUGH, ENGLAND

An Eye for PERFECTION

There's no second best at National. You get top quality and top performance in every National Roll you buy.

In the National foundry only the latest metallurgical practices are employed to assure sound roll castings. And in the modern roll shop, only the newest in machine tool equipment is used to finish roll surfaces. Add the specialist's eye for perfection and it all sums up to real roll value.

National Rolls

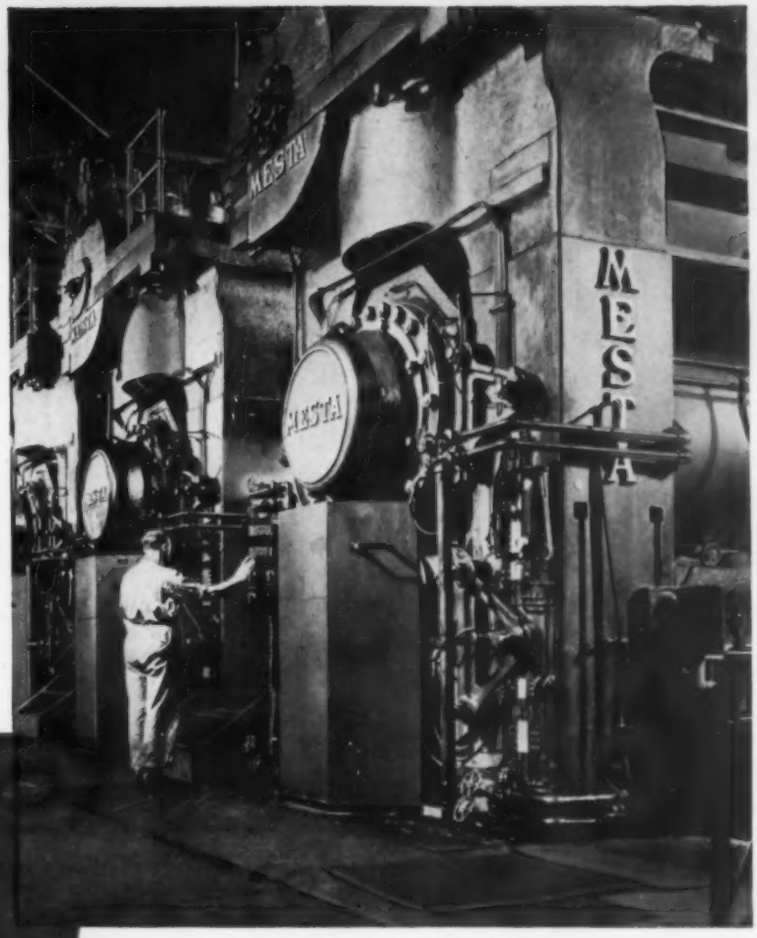
THE NATIONAL ROLL & FOUNDRY CO.

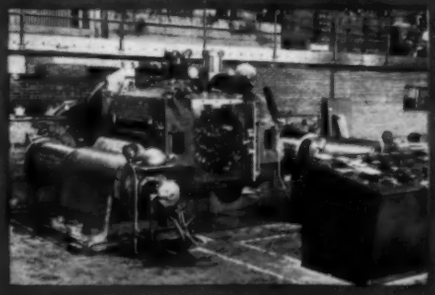
AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON AND ALLOY IRON ROLLS

REGARDLESS OF SIZE

Use Texaco Lubricants to assure trouble-free performance and lower maintenance costs





Sendzimir cold strip mill — the world's smallest — reduces .250 gauge to .001, handles everything from stainless steel to aluminum. Now made in the U. S., the Sendzimir mill is particularly useful where extreme accuracy in rolling is desired.

ON the smallest specialty strip mills . . . as on the giants in the heaviest steel mill service . . . Texaco Lubricants are doing an outstanding job of protection . . . assuring uninterrupted operation . . . longer life for bearings and gears . . . reduced maintenance costs.

For heavy-duty enclosed gear drives (pinion and worm), use *Texaco Meropa Lubricants.* They have an extra-high load-carrying capacity . . . resist oxidation and thickening . . . cling persistently to the gear teeth . . . do not foam. In addition, they prevent bearing corrosion, and do not separate in service, storage or centrifuging.

For oil circulating systems, use *Texaco Regal Oils.* These are turbine-grade oils that carry heavy loads easily . . . resist oxidation, emulsification and sludging . . . stand up under high temperatures. They keep oil lines clear . . . bearings protected with an uninterrupted flow of cool, clean lubricant.

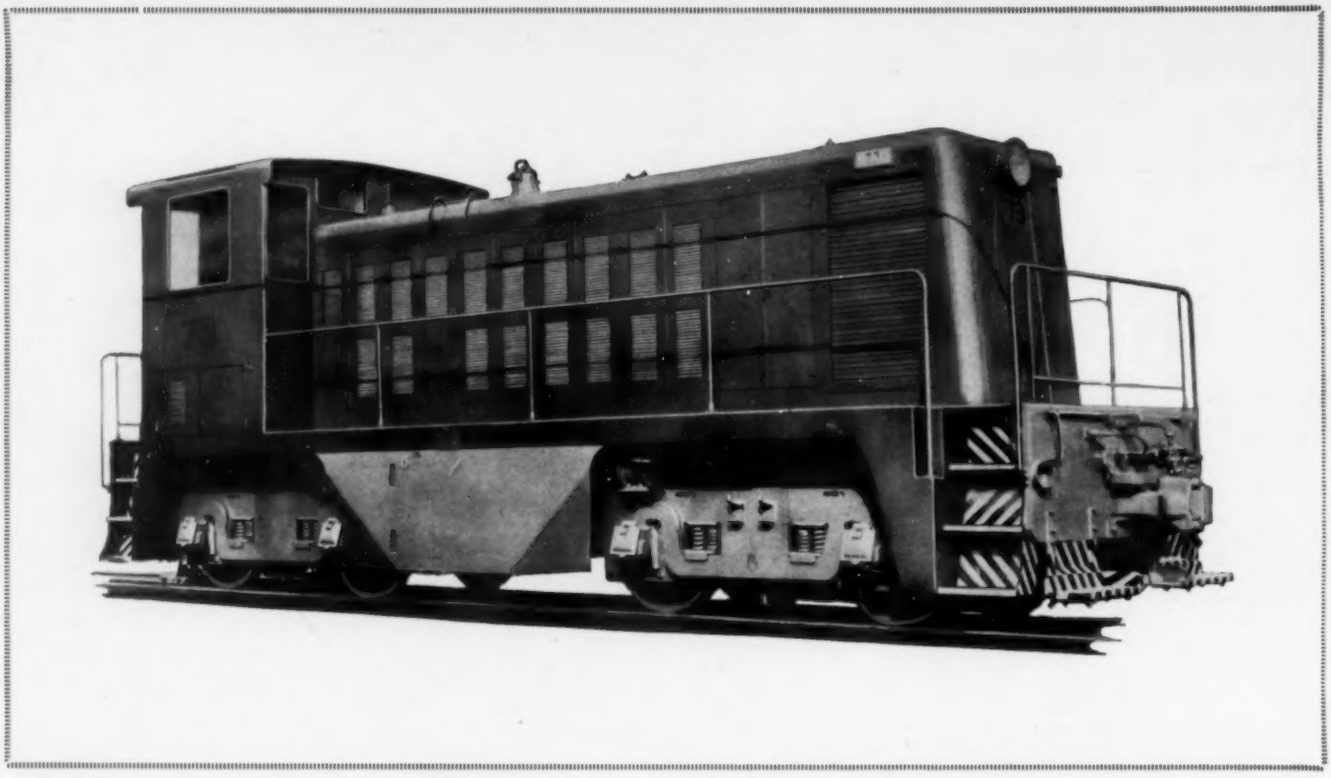
Let a Texaco Lubrication Engineer work with you on *all* your lubrication. Just call the nearest of the more than 2500 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Meropa Lubricants

FOR STEEL MILL GEAR DRIVES

Tune in . . . Texaco Star Theatre every Wednesday night featuring Gordon MacRae and Evelyn Knight . . . ABC Network



YOU GET "LAGNIAPPE" WITH YOUR NEW WHITCOMB

"LAGNIAPPE" is a Creole word used colloquially in Louisiana. It means "a little something extra." It is used here because it so aptly describes the characteristics of Whitcomb locomotives that are not visible. This something extra you get with every Whitcomb Diesel mechanical or Diesel electric locomotive is really something worth considering. For instance: Whitcomb locomotives are powerful enough to perform their given assignments — plus a little extra power. They do their jobs efficiently — and a little better. All the parts are instantly accessible for quick maintenance—and even sooner. They are durable for years of service — plus a few more years.

There is only one thing about a Whitcomb that cannot give extra service: that is its availability — it is available only 24 hours in each day.

Diesel Electric and Diesel Mechanical locomotives to 95 tons

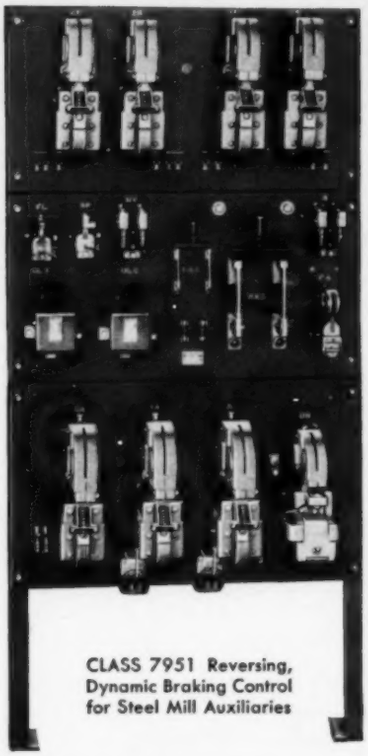
BLW
THE BALDWIN GROUP

THE WHITCOMB LOCOMOTIVE CO.

ROCHELLE, ILL.

Subsidiary of THE BALDWIN LOCOMOTIVE WORKS

CONTACTOR *Performance*



CLASS 7951 Reversing, Dynamic Braking Control for Steel Mill Auxiliaries

Another Reason for Specifying SQUARE D *Heavy-Duty D. C. Control for Mill Auxiliaries . . .*

Strong blowout coils, in combination with chimney type arc barriers, give high rupturing capacity and long contact tip life.

Heavy copper contacts are backed up by substantial supports which relieve the studs of impact and conduct away heat dissipated in the arc. Ample wear allowance provided without adjustment.

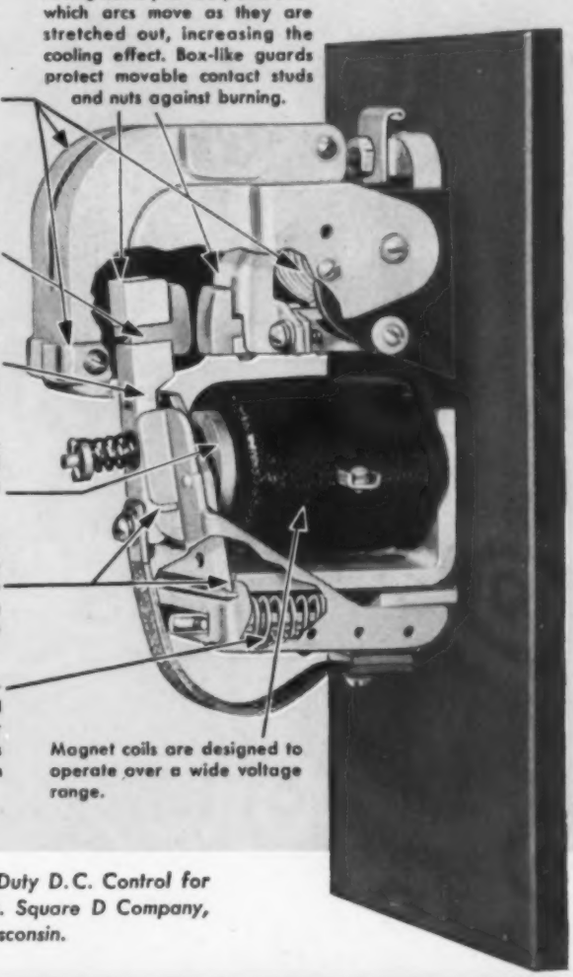
Extruded fingers provide ample current-carrying capacity without excessive inertia. Contact "bounce" is minimized.

Laminated magnet cores avoid the effect of residual magnetism without reducing mechanical life.

Knife-edge bearings are provided for both armature and finger. Wear is immediately taken up by the spring pressure applied to hold the knife-edge to its seat.

Opening speeds are increased, and accidental closing from vibration or sway prevented, by means of easily adjusted return springs.

Arcing horns provide paths over which arcs move as they are stretched out, increasing the cooling effect. Box-like guards protect movable contact studs and nuts against burning.



Magnet coils are designed to operate over a wide voltage range.

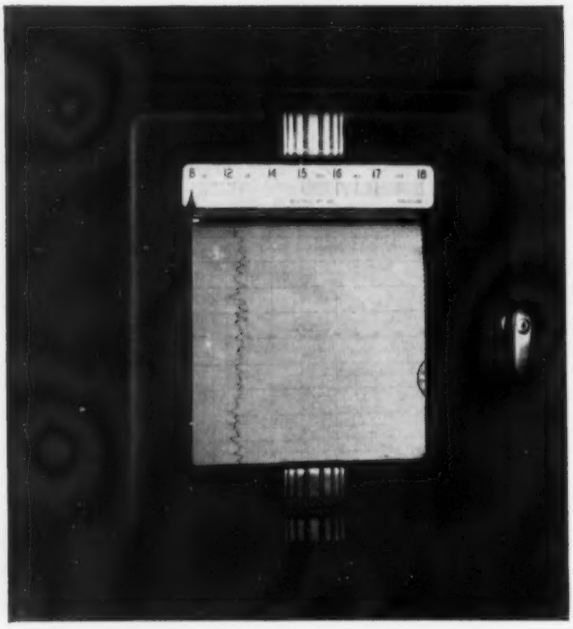
SQUARE D Contactors are available with 8 hour ratings of 100, 150, 300 and 600 amperes and mill ratings 133% of those values. Normally closed contactors for dynamic braking have similar construction features.

Write for information on the CLASS 7950 SERIES Heavy Duty D.C. Control for cranes and mill auxiliaries and CLASS 9003 Master Switches. Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S.A., MEXICO CITY, D.F.



As seamless tube emerges from the reheating furnace ahead of the sizing operation, Rayotube detects temperature along the entire length of the moving tube and reports it to the Speedomax Recorder. This enables the furnace operator to keep the tube at the desired temperature by adjusting the fuel supply to the furnace.

Accurate Annealing for Seamless Tubes With Speedomax Pyrometer & Rayotube

When high alloy steel is processed into seamless tubing, the problem of maintaining correct temperature of the steel is essential. The manufacturer must know that the tube has been rolled at the proper temperature to insure meeting the physical requirements.

In the installation pictured here, the combination of a Rayotube radiation detector and a Speedomax temperature recorder is a practical answer to this problem.

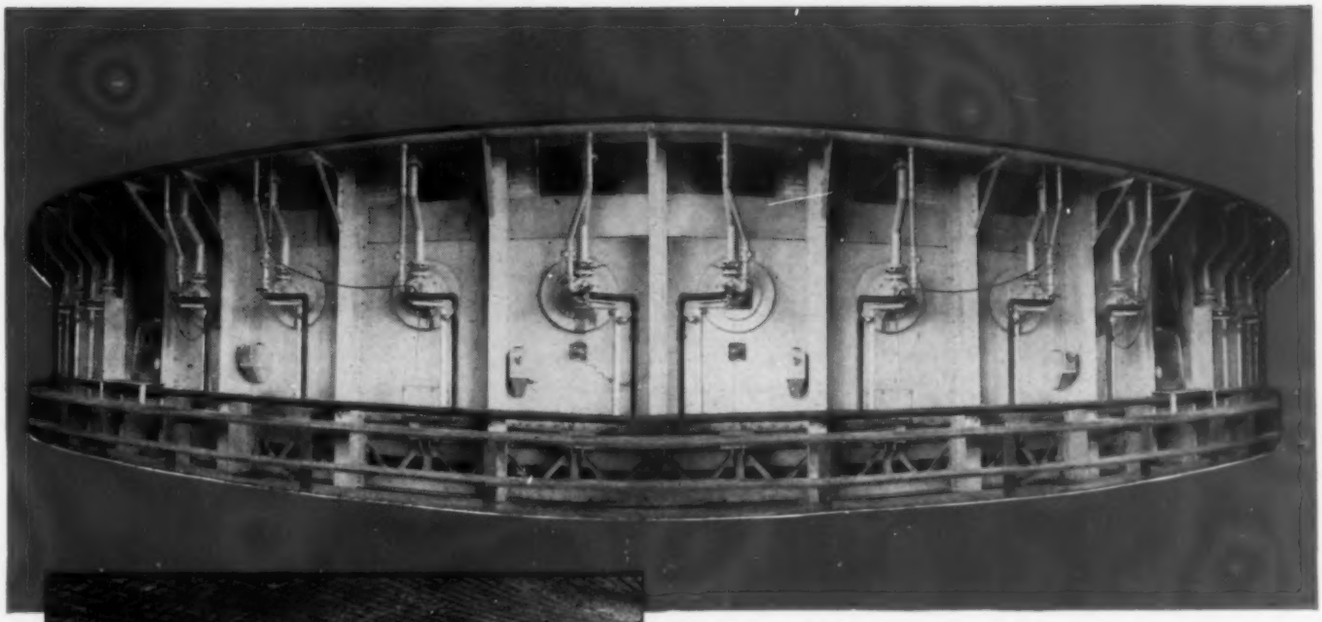
The high-speed recorder gives the furnace operator all the temperature information he requires, and draws a permanent record of the temperature of the tubes along their entire length.

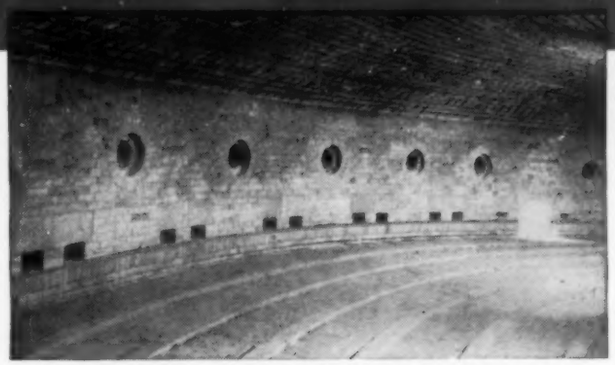
Our complete family of temperature recorders and controllers provides an answer to almost any temperature problem. An L&N engineer will be glad to help you select one. For a personal call, or information by mail, as you prefer, write to Leeds & Northrup Co., 4942 Stenton Avenue, Philadelphia 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

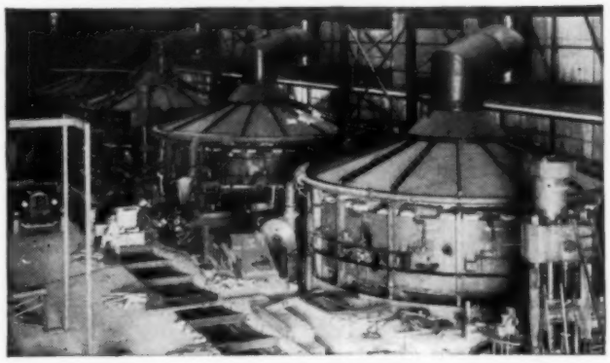
LEEDS & NORTHRUP CO.

Jrl. Ad N-33B-626(1)





Inside View of the World's Largest Rotary



SALEM ROTARY FURNACES

. . . are fuel savers because waste gases counterflow the work and exit at the exhaust flue provided for each zone only after giving optimum heat release. This arrangement permits the selective closing of flues to satisfy certain heating rates on special charges.

Flexibility of design insures positive control as well as fuel economy.

SALEM ENGINEERING CO. • SALEM, OHIO
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SALEM

ALL OFFICES STAFFED FOR ENGINEERING, CONSTRUCTION and OPERATION

Salem Builds

CIRCULAR SOAKING PITS
ROTARY HEARTH FURNACES
CONTINUOUS BUTT-WELD FURNACES
CAR BOTTOM FURNACES
FORGE FURNACES
HEAT TREATING FURNACES
NEEDLE METALLIC RECUPERATORS
AIR RECIRCULATING FURNACES
GAS ATMOSPHERE FURNACES
MECHANICAL EQUIPMENT FOR CHARGING AND DISCHARGING MATERIAL FROM FURNACES

VALIMITOR*

(VOLT-AMPERE-LIMITOR)

★ TRADE MARK

LIMITS "FAULT" CURRENTS TO 25,000 KVA

(STEADY STATE CURRENT)

These VALIMITOR Starters may be used *with safety* at *any* point on *any* power system regardless of the available KVA. Even if connected to a bus of *infinite* capacity, the short circuit KVA will be limited to a value easily interrupted by the starter-contactor.

Because VALIMITOR Starters limit the maximum possible fault current to approximately 25,000 KVA, damage to a short-circuited motor is limited. Also limited is the electro-magnetic forces on the starter, bus, cables and the entire high voltage system back to the power source.

There is nothing to replace, when a fault occurs. The magnetic overload relays on the VALIMITOR Starter promptly open the *high arc-rupturing capacity starter-contactor* to clear the line. *Don't worry* about the short-circuit possibilities your motor drives may be subjected to — *now or at some future date.*

For a specific problem, tell us

1 Type of motor (squirrel-cage, wound-rotor or synchronous)

2 HP, voltage, phase and frequency

3 Type of starter—*reduced* or *full* voltage starting—combination type or without disconnects.

—so that we can write you fully

THE ELECTRIC CONTROLLER & MFG. CO.

2698 East 79th Street • Cleveland 4, Ohio

Be Safe with EC&M VALIMITOR STARTERS

NOTHING TO REPLACE • NO CHANGE LATER ON

Even their Best Friends hadn't told them about

Permanently Insulated

ROCKBESTOS A.V.C.

Rockbestos A.V.C. is the cable that gives you *pre-assured* trouble-free service.

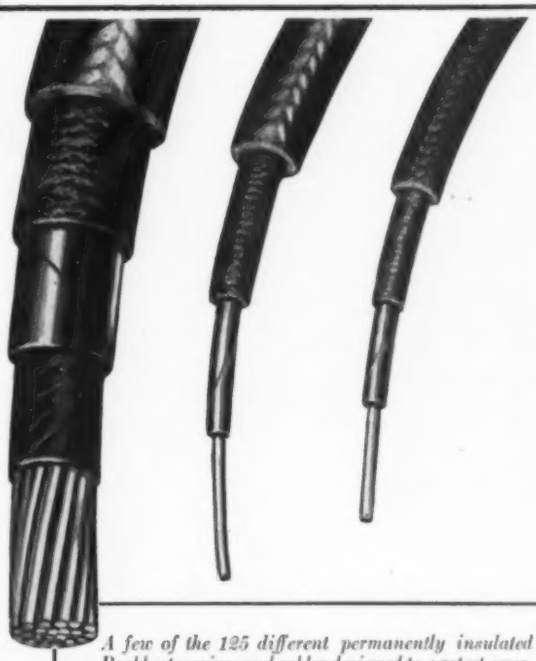
Pre-assured because this is the cable that's permanently insulated with *impregnated asbestos.* To you that's important. It means you're getting a cable that you know . . . in advance . . . won't rot or bloom when exposed to fumes, grease or oil; won't bake brittle when exposed to constant high temperatures up to 230° F.; won't break down (where others so often do!) when exposed to severe heating and cooling cycles in conduit.

So, next time . . . try Rockbestos A.V.C. for consistent high performance in hot spots. Types AVA, AVB, AVL and AIA for control, lighting and power circuits in 600 to 5000 volt ratings.

Write—*today*—for your copy of the new No. 10-F Catalog, sectioned for easy reference to permanently insulated Apparatus Wires and Cables; Lighting Wires; Power and Control Cables; Switchboard, Appliance, Fixture, Electronic, Aircraft and Magnet Wires.

ROCKBESTOS PRODUCTS CORP., 633 NICOLL ST., NEW HAVEN 4, CONN.

NEW YORK BUFFALO CLEVELAND DETROIT CHICAGO
PITTSBURGH ST. LOUIS LOS ANGELES OAKLAND, CALIF.



A few of the 125 different permanently insulated Rockbestos wires and cables designed to protect operations and reduce maintenance in control, lighting and power circuits. From left to right:

Type AVA 600 Volt Rockbestos A.V.C. Power Cable*
Type AVA 600 Volt Rockbestos A.V.C. Boiler Room Wire
Type AVB 600 Volt Rockbestos A.V.C. Switchboard Wire
*Other single and multi-conductor cables up to 5000 volt rating—also with lead sheath, armor or lead sheath and armor coverings.

ROCKBESTOS A.V.C. ROCKBESTOS **The Wire with Permanent Insulation**

Modern Blooming-Slabbing Mill Uses amplidyne-controlled TWIN DRIVES

Higher reversal and average speeds, larger tonnages made possible by amplidyne control of acceleration, deceleration, torque balance, and speed

In a large steel mill west of the Mississippi, one big reason for the 45-in. blooming-slabbing mill's high output is the G-E twin-motor reversing drive. Keyed to an adjustable-voltage amplidyne control system, this drive gives the operator an improved method of maintaining voltage for any given operating point, permits the higher average speeds that increase mill production. It also gives these specific advantages:

—**Provides** accurate control of acceleration and deceleration, maintaining maximum rates at all times. After running in one direction for a few revolutions, the mill can be quickly reversed (from base speed to base speed in 1½ seconds or less).

—**Assures** effective control of load limits, making maximum torque output of motors available as needed, for heavy passes at low speed and lighter passes at higher speed.

—**Reduces** the number of control devices required by about half, greatly simplifying the control scheme.

—**Maintains** accurate load balance between two or more machines operating in parallel, and proper torque and speed balance on both units of the twin-drive.

—**Keeps** motors and generators fully protected at all times against overcurrent, overvoltage, and overspeed for greater service continuity, longer equipment life.

—**Provides** definite, easily-selected speed points in both forward and reverse; permits low creeping speed to keep rolls turning slowly between passes for uniform cooling; eliminates creeping when necessary to line up couplings for changing rolls.

Whether you plan to install a new reversing-mill drive or modernize an existing one, General Electric can meet your need for higher speed and more accurate control. Call in a G-E steel mill engineer to talk it over. There's no obligation. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

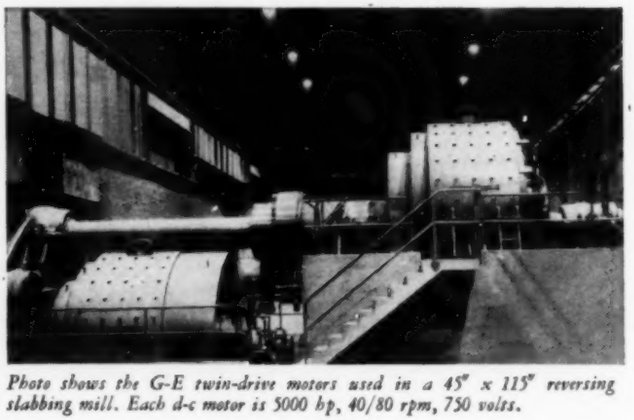
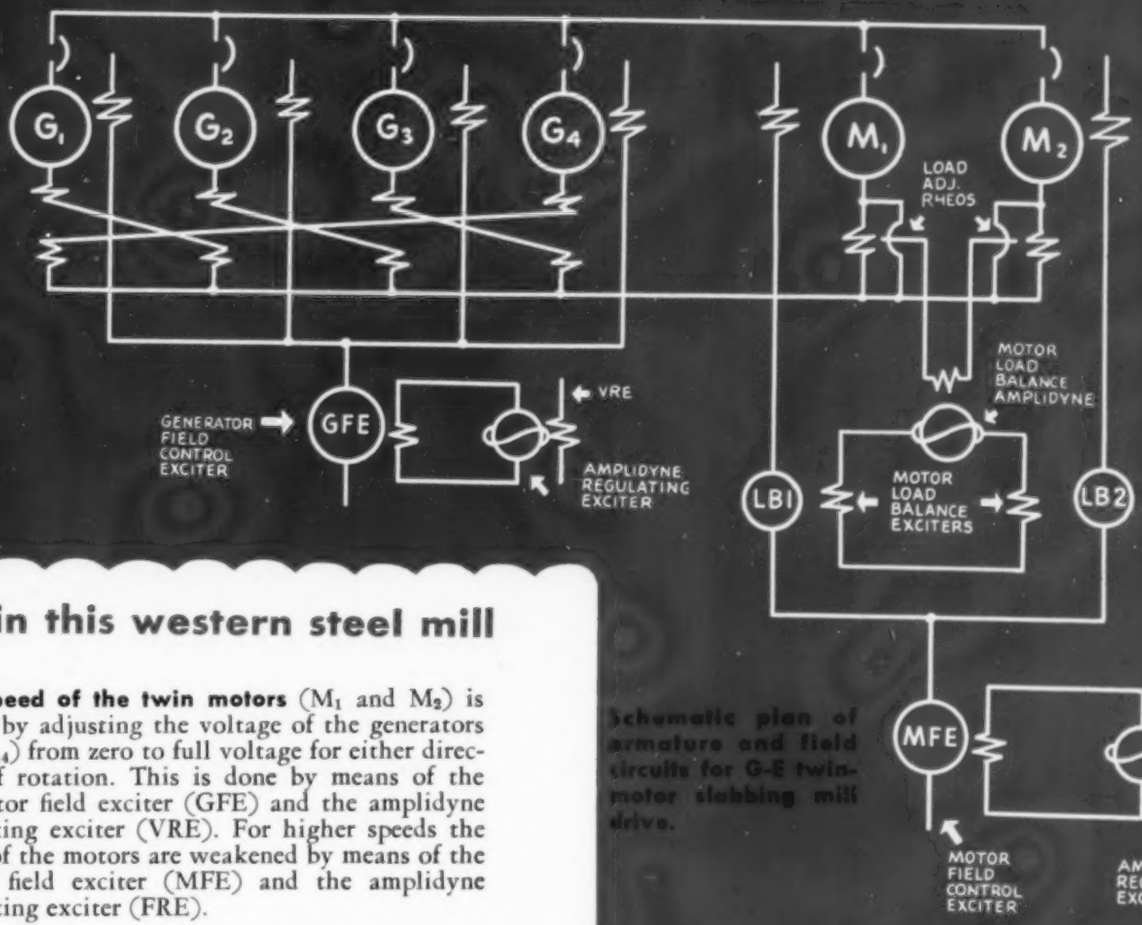


Photo shows the G-E twin-drive motors used in a 45" x 115" reversing slabbing mill. Each d-c motor is 5000 hp, 40/80 rpm, 750 volts.

GENERAL ELECTRIC

HOW THE G-E DRIVE WORKS . . .



Schematic plan of armature and field circuits for G-E twin-motor slabbing mill drive.

. . . in this western steel mill

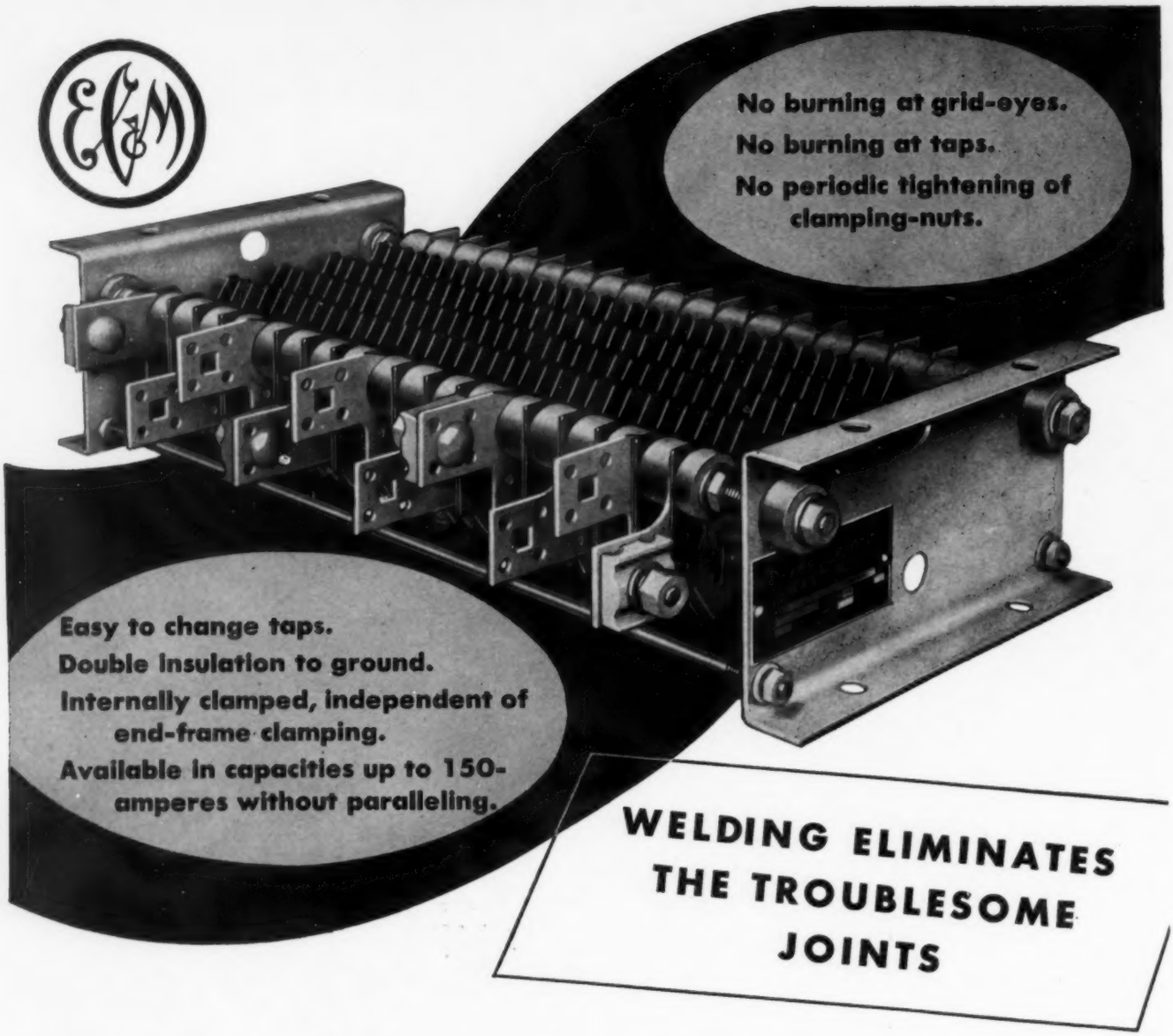
The speed of the twin motors (M_1 and M_2) is varied by adjusting the voltage of the generators ($G_{1,2,3,4}$) from zero to full voltage for either direction of rotation. This is done by means of the generator field exciter (GFE) and the amplidyne regulating exciter (VRE). For higher speeds the fields of the motors are weakened by means of the motor field exciter (MFE) and the amplidyne regulating exciter (FRE).

The regulating exciters (VRE and FRE) cause the twin motors (M_1 and M_2) and the mill to operate in a direction and at a speed determined by the position of the operator's master switch. In doing so, these amplidynes automatically limit the armature circuit current to a definite value. If, when operating with weakened motor fields, the operator tries to take an excessive draft, the amplidyne (FRE) acts to limit armature current. This it does by strengthening the motor fields, thereby supplying increased torque at lower speed.

Motor M_1 drives the upper work roll. Motor M_2 drives the lower work roll. Motor load balance amplidyne (LB) measures the difference between the two motor load currents. Amplidyne (LB) supplies excitation to the motor load balance exciters (LB_1 and LB_2) so as to strengthen the field of the motor carrying the higher load and weaken the field of the motor carrying the lower load. This restores the load current balance.

another example of

drive engineering at work!


No burning at grid-eyes.
No burning at taps.
No periodic tightening of clamping-nuts.
Easy to change taps.
Double insulation to ground.
Internally clamped, independent of end-frame clamping.
Available in capacities up to 150-amperes without paralleling.

WELDING ELIMINATES THE TROUBLESOME JOINTS

Electrical resistors operate over a wide temperature range and are subject to highly repetitive expansion and contraction. This alternate heating and cooling throws a heavy burden on the method used to maintain electrical contact between adjacent grids and at the points where taps are taken off. In EC&M TAB-WELD Resistors, tap-plates are welded in place and *cannot loosen*. Mated ends of adjacent resistors are spot-welded to form a *continuous path* throughout the entire section. Cut maintenance costs with TAB-WELD Resistors.

TRADE MARK
TAB WELD
PLATE RESISTOR
PATENT NO. 2,378,038

SPECIFY EC&M Bulletin 942
TAB-WELD Resistors.

THE ELECTRIC CONTROLLER & MFG. CO.

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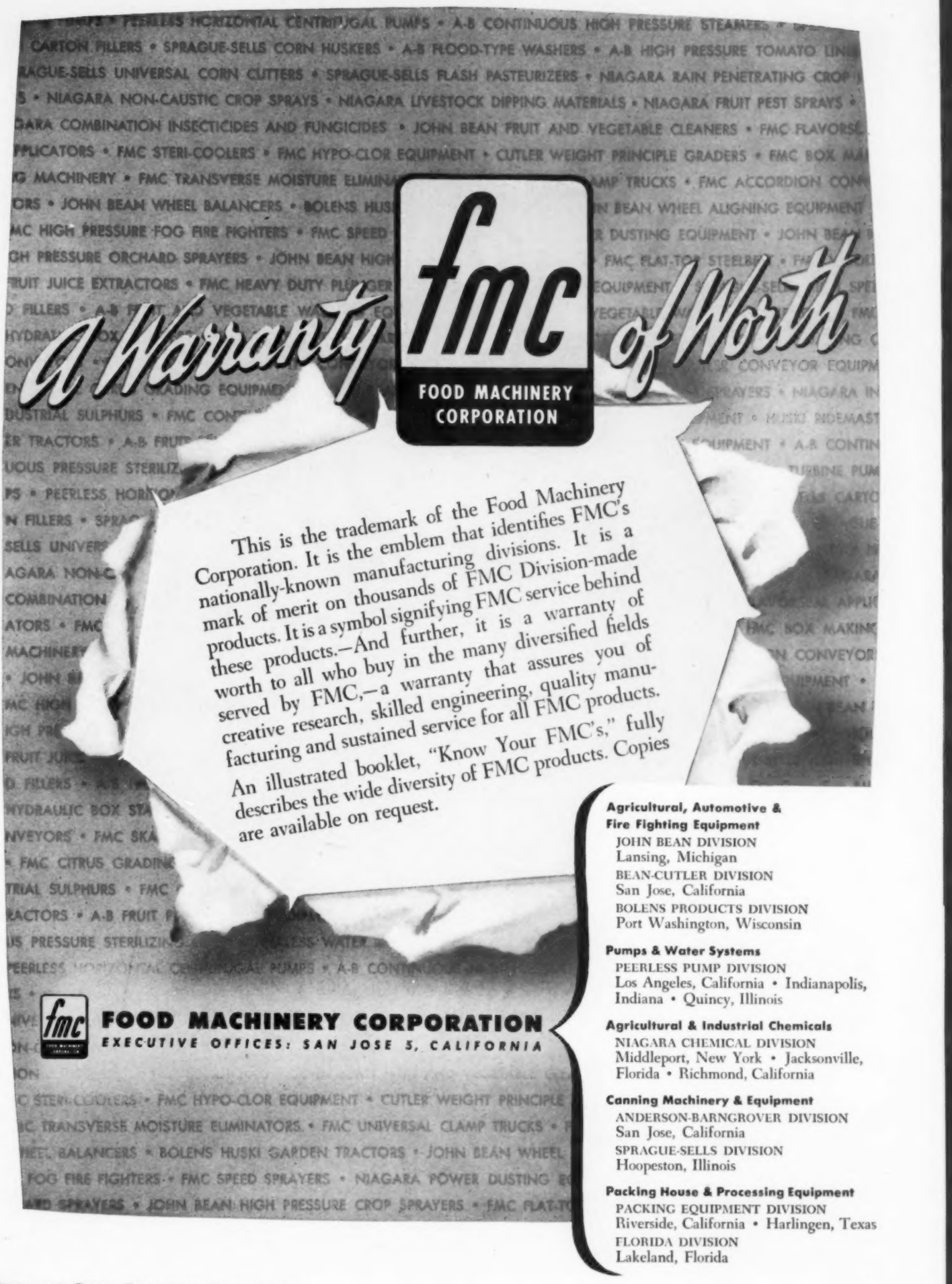
A Warranty of Worth
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FOOD MACHINERY CORPORATION
This is the trademark of the Food Machinery Corporation. It is the emblem that identifies FMC's nationally-known manufacturing divisions. It is a mark of merit on thousands of FMC Division-made products. It is a symbol signifying FMC service behind these products.—And further, it is a warranty of worth to all who buy in the many diversified fields served by FMC,—a warranty that assures you of creative research, skilled engineering, quality manufacturing and sustained service for all FMC products.
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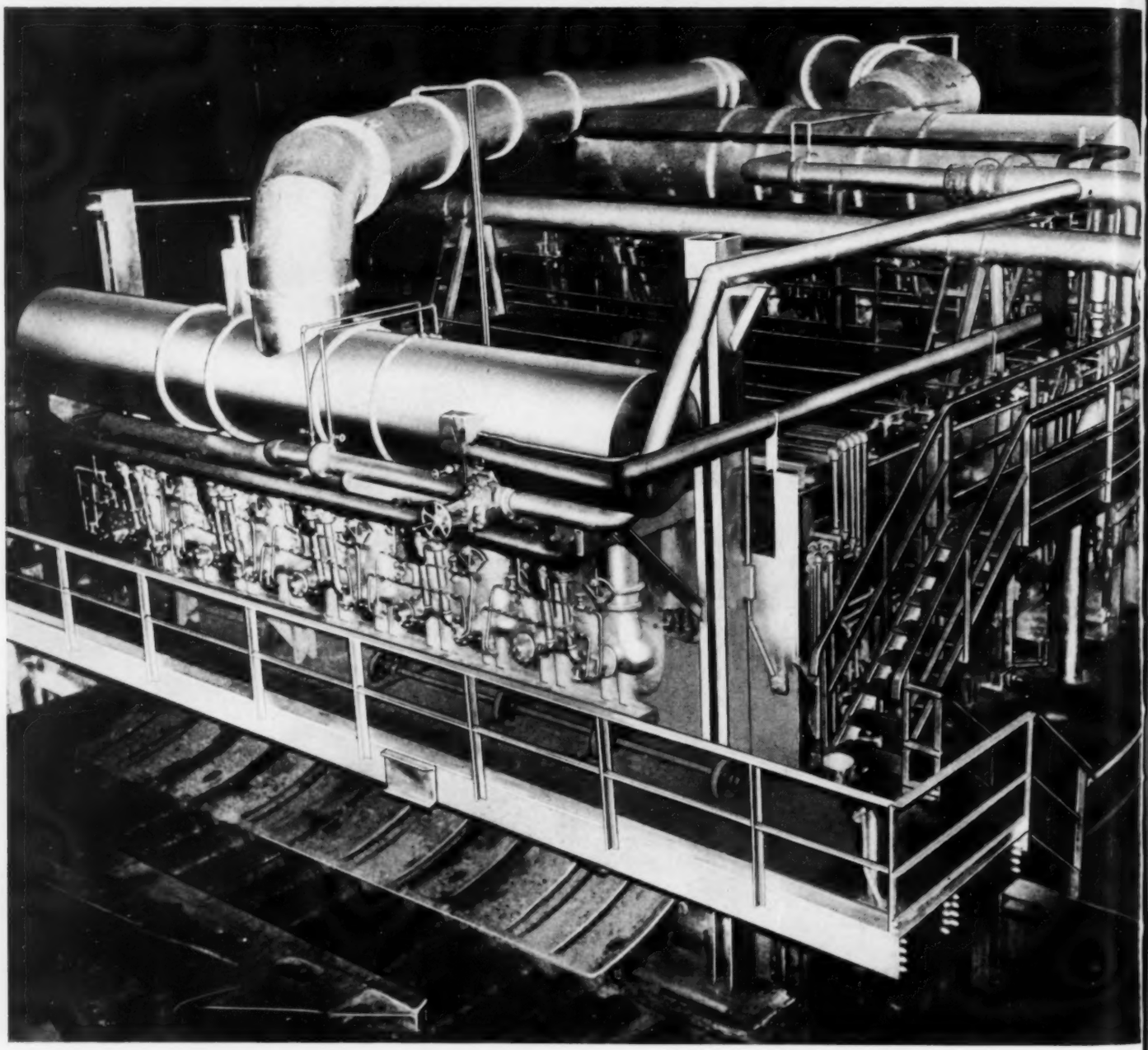
The World's Largest



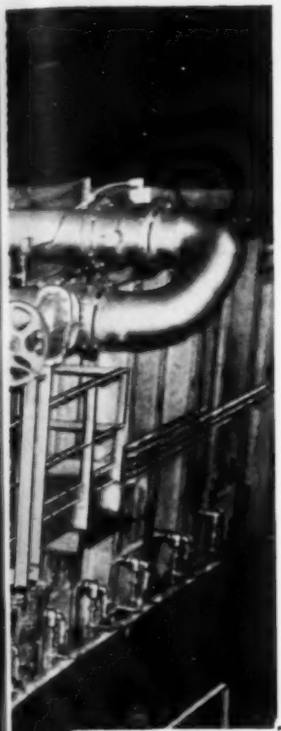
World's Largest Slab-Heating Furnace in Weirton Steel Company's Hot-Strip Mill

AMERICAN ARCH

1430 Park Building, Pittsburgh, Pa.

REPRESENTATIVES: BIRMINGHAM • CHICAGO • CINCINNATI

Slab-Heating Furnace

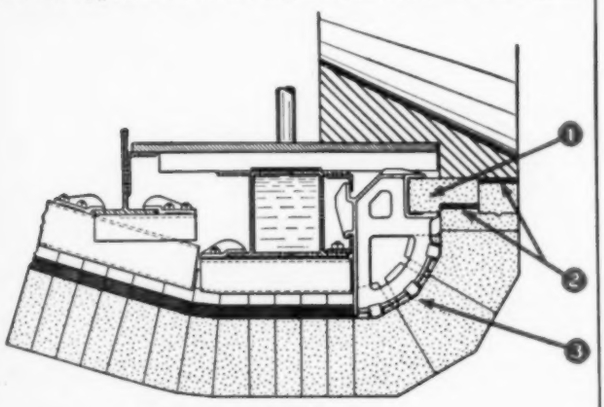


has AMERICAN SUSPENDED ARCH ROOF

This giant furnace in Weirton's hot-strip mill, at Weirton, West Virginia, has an American Suspended Arch Roof and Nose Construction. After nearly three years of continuous service, a single cent has yet to be spent for maintaining the suspended roof or nose.

All other furnaces in this plant, with suspended arches, are of American Arch construction.

Section of typical modern American nose construction



1 Load-bearing support tile
2 Ship-lapping expansion joints
3 Full effective burning depth of tile is utilized
Tile is of correct thickness

In this furnace the Suspended Nose Construction is of the most modern American Arch design.

The tile is of the correct thickness for the most satisfactory machine pressing, insuring uniformity of quality throughout. For maximum strength, the tile is made nearly the same thickness at the supporting end as in the main body.

Replacement of nose tile does not require the removal of any bolts.

The burner wall above the nose is so supported that the nose tile is relieved of any strain from the weight of the wall. This is accomplished without sacrificing any of the effective burning depth of the tile.

Finally, ship-lapping expansion joints prevent any danger of the flame reaching the supporting castings.

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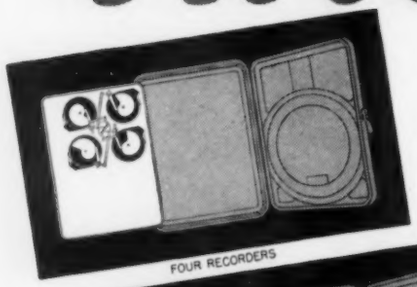
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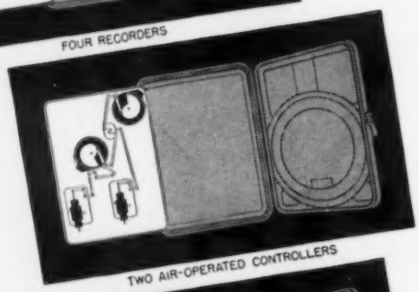
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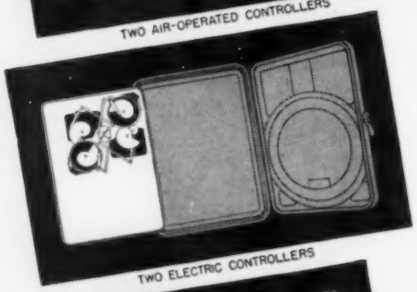
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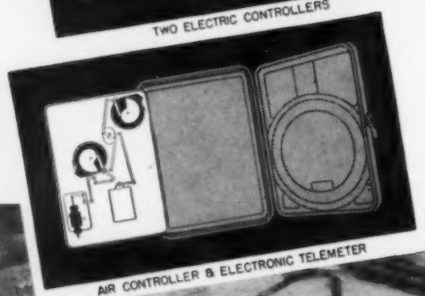
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What's your control problem? Flow—temperature—level? Are you using solids—liquids—gases?

No matter what you process, four basic circuits and eight basic component parts will give you more than 100,000 different electronic measuring and controlling combinations. That's how Bailey has simplified controls for processing industries.

The four arrangements illustrated show how easily Bailey interchangeable parts can be used. It's no longer necessary to carry a huge stock of replacement parts for emergency control installations. When you standardize on Bailey controls you are always ready to meet changing conditions within your plant.

And with Bailey simplified controls, your maintenance costs will be less. Maintenance men quickly become familiar with Bailey controls and spend less time on maintenance and installation.

To see for yourself how you can profit with Bailey controls, write for a copy of our bulletin No. 17.

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BAILEY METER CO. LIMITED, MONTREAL
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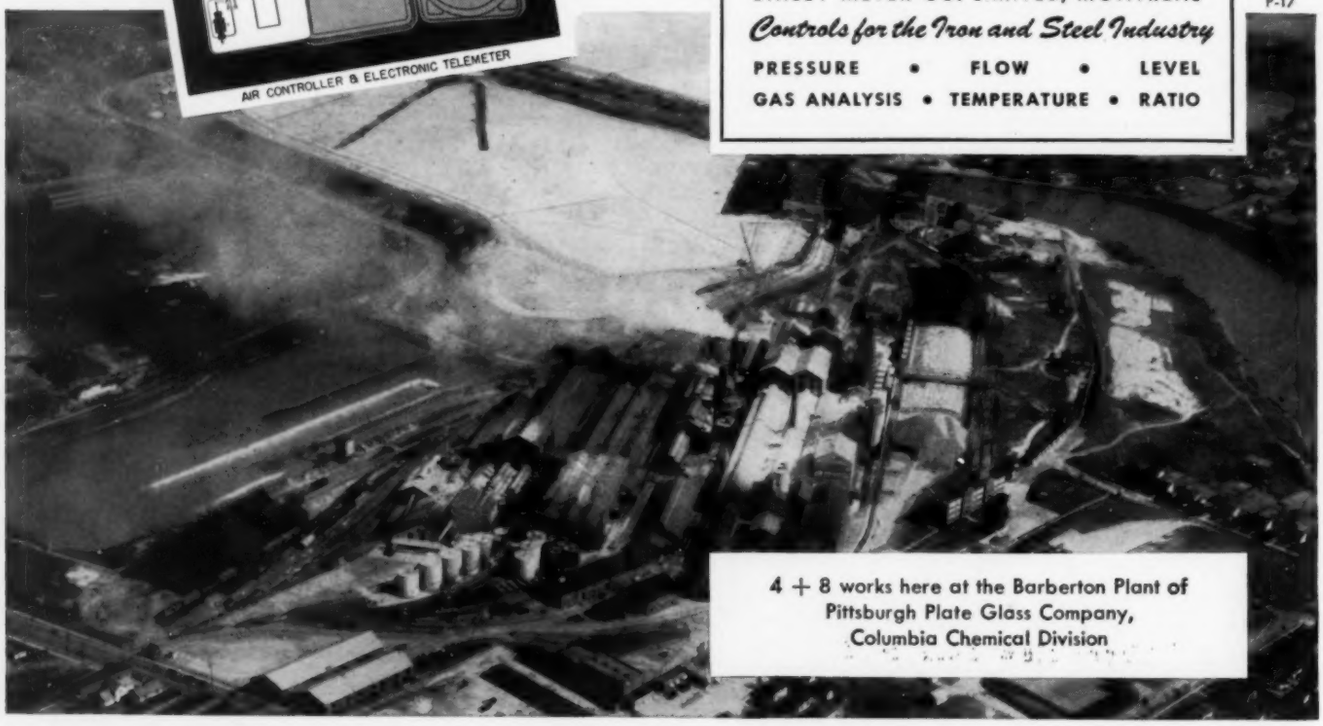
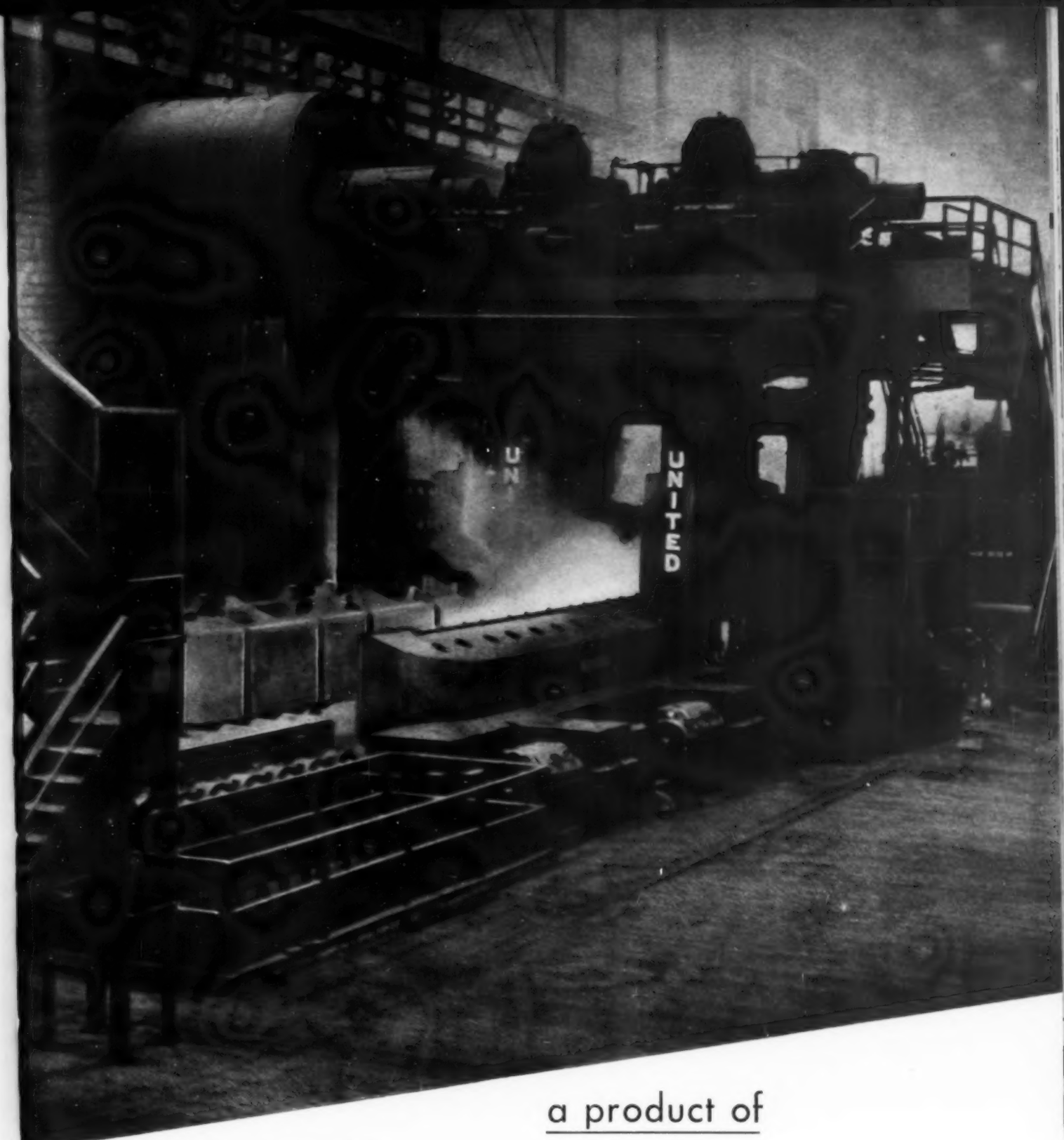


4 + 8 works here at the Barberton Plant of Pittsburgh Plate Glass Company, Columbia Chemical Division



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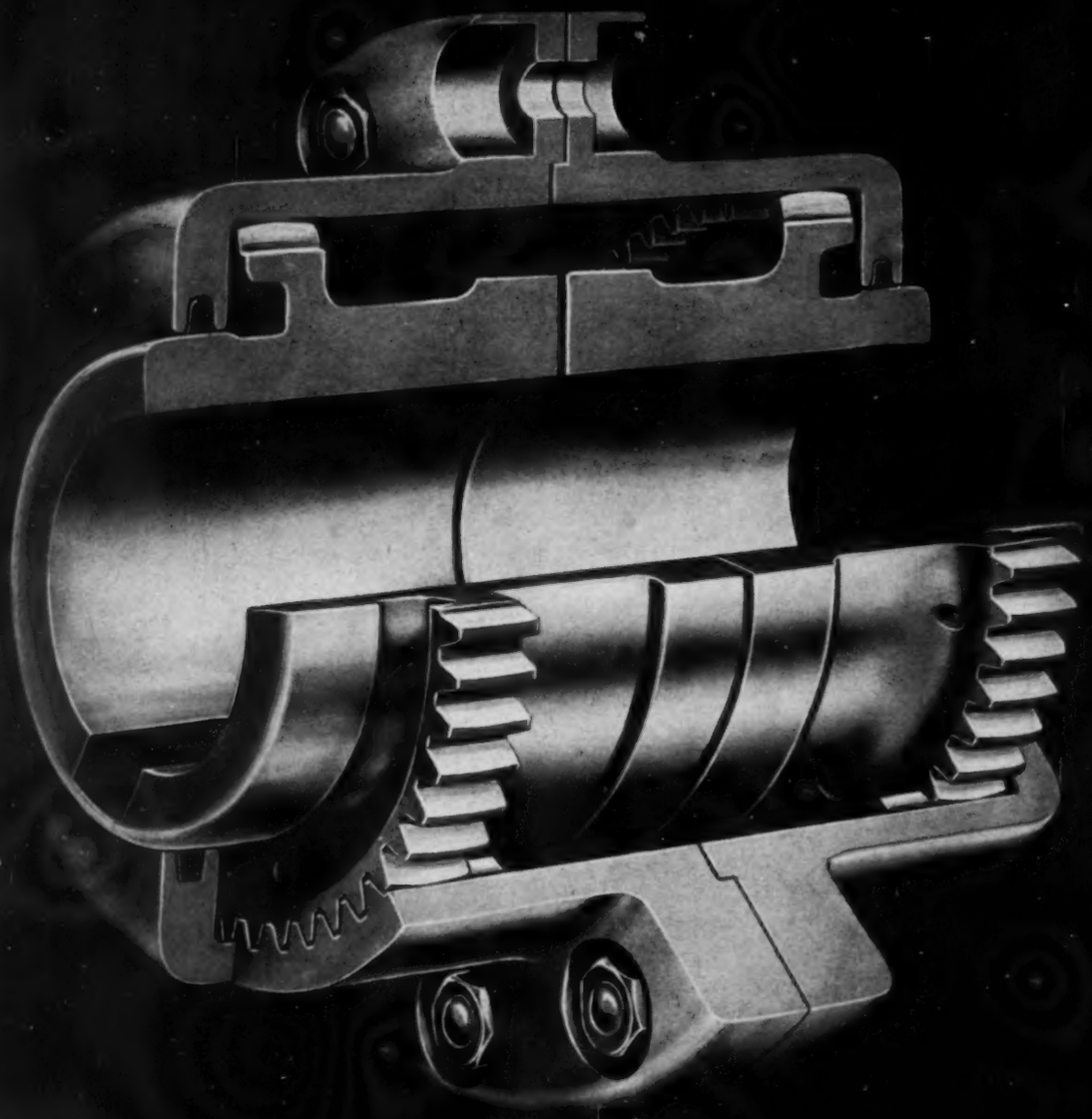

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WOODBERRY, BALTIMORE, MD.

PRODUCT Information

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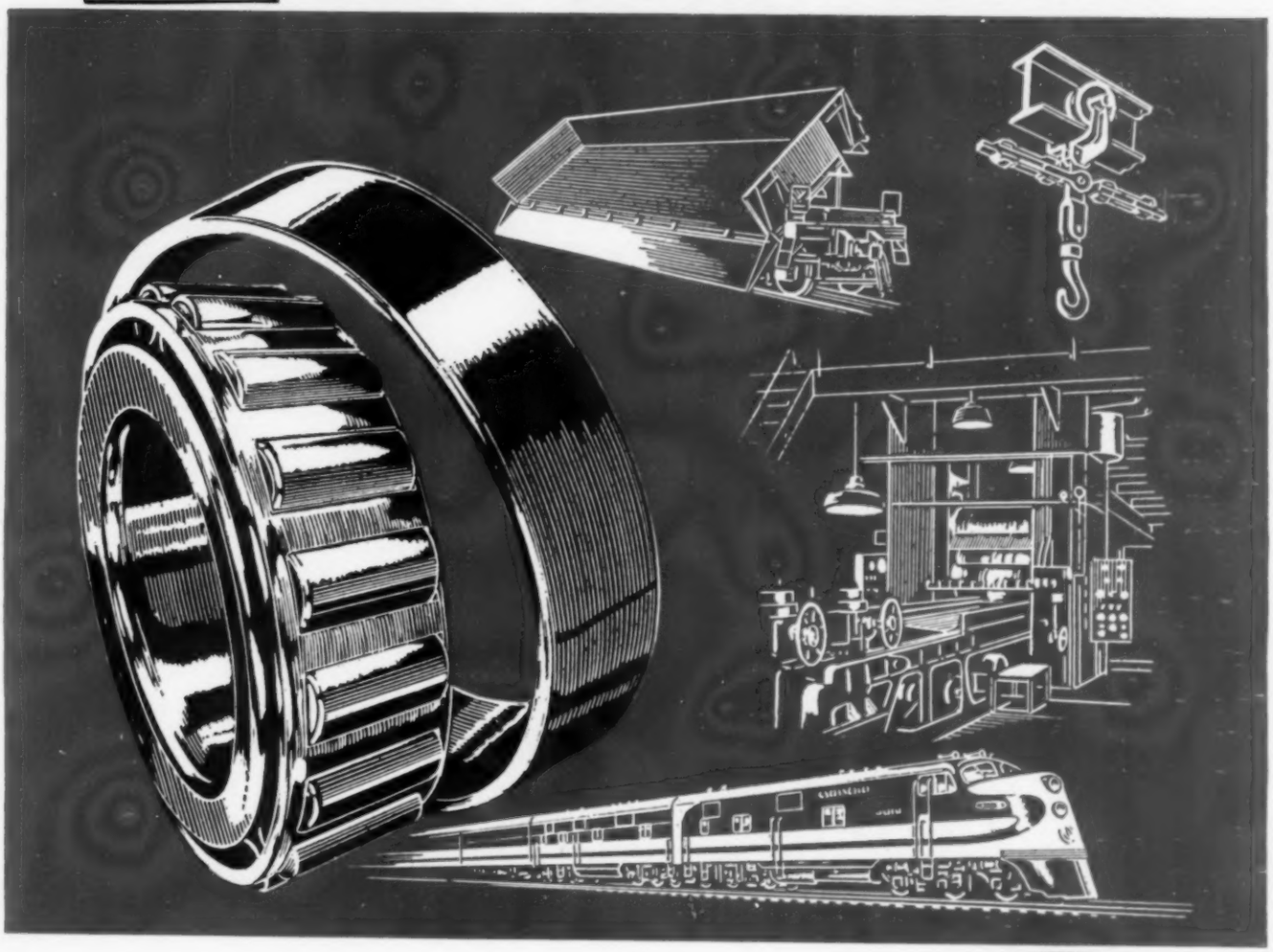
YES! Tycol Acylkup Greases perform better . . . BETTER . . . BETTER



Tycol Acylkup Greases perform better because:

. . . *Tycol Acylkup Greases* are made from finest quality cylinder stocks and refined neutral oils, combined with a minimum of soap.

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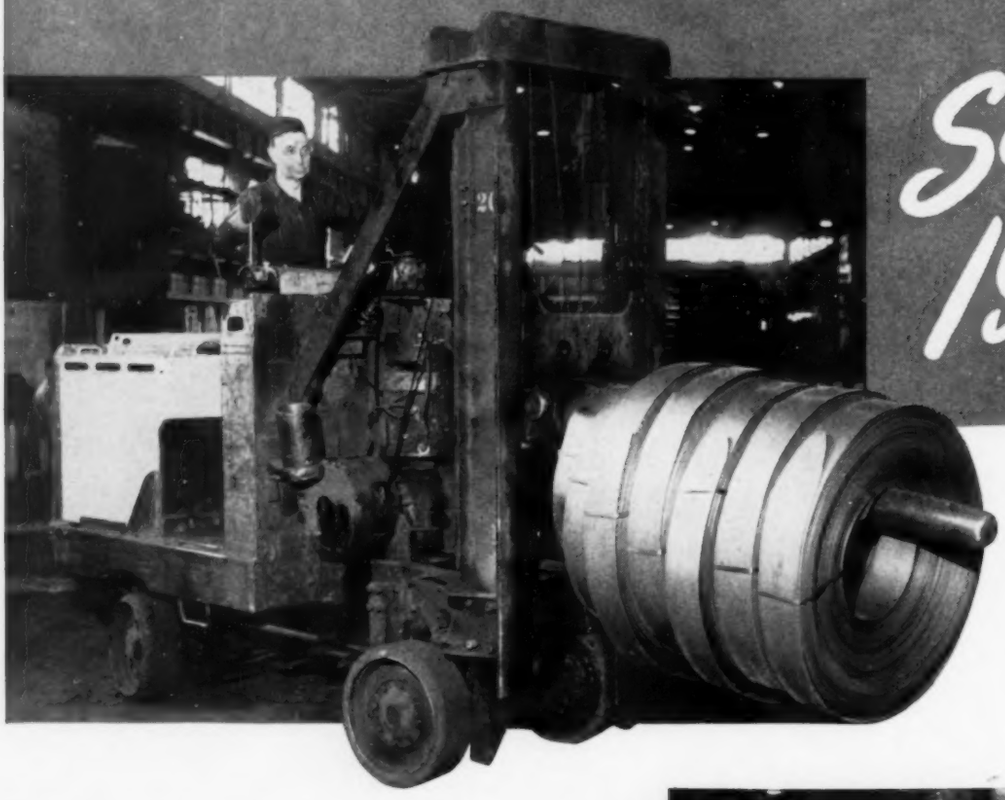
LUBRICATION—"ENGINEERED TO FIT THE JOB"

One BAKER TRUCK has handled OVER 4,000,000 TONS OF STEEL

Since 1923!



Baker Ram Truck. 25 years old, handling 6600 lbs. of coiled strip—with operator who has been on the job as long as the truck.

Two Baker Ram Trucks taking steel from end of hot strip mill. Original truck in foreground. Loads exceed 6000 lbs.

On February 13, 1923, the first ram truck ever built for handling coiled strip went into service for a large steel mill in Ohio. Since then, this Baker Truck has been operating continuously—usually 24 hours per day. For 25 years it has been on the same job, taking coiled steel from the hot strip mill to storage. As of January 1, 1948, this truck had handled 4,080,297 tons of steel *and is still going strong!*

More recently this mill has purchased several modern Baker Ram trucks—like this 12,000 lb. model handling coils from end of welding line.

This truck, the forerunner of modern Fork, Ram and Hy-Lift Trucks, performed so well that five more like it were purchased during the next two years. These, too, have given continuous service—24 hours per day—and are still on the identical jobs for which they were purchased a quarter of a century ago. It is conservatively estimated that these six trucks have handled a total of over 16,000,000 tons of steel—averaging only about one day per month out of service for maintenance.

Let a Baker Material Handling Engineer demonstrate how records like this can be made in your plant.

BAKER INDUSTRIAL TRUCK DIVISION *of The Baker-Raulang Co.*
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Baker INDUSTRIAL TRUCKS

FIGURE IT IN ALUMINUM

For new plants, for rewiring for additional load—you'll save *big money* if you *figure it in aluminum!*

The lighter weight of insulated wire and cable with Alcoa E.C.* Aluminum Conductor means startling differences in wiring costs. A 500 mcm insulated aluminum cable weighs less than half the weight of an identical copper cable.

First costs are lower. Transportation costs are less. Installation is easier. Mechanical joints are easy with standard connectors for aluminum—soldering, too, with Alcoa Solder and Flux. *Welded* terminals and splices are highly efficient and easily made with aluminum.

Alcoa makes light, strong, conductive E.C. Aluminum; leading wire manufacturers draw, strand and insulate it, sell it under their own trademarks. They have it now. ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh 19, Pennsylvania. *E. C.: *Electrical Conductor* Aluminum

The BIG DIFFERENCE is in your COSTS!

YOUR SUPPLIER HAS IT!

ALCOA EC ALUMINUM

FOR ELECTRIC WIRE AND CABLE

Johnston Corrugated Cinder Pot Performance Key to Slag Handling Economy

View showing Johnston Corrugated Cinder Pots at slag dump, Weirton District

Close-up of Johnston Corrugated Cinder Pot

Continuous Developments Increase Service Life of Johnston Corrugated Cinder Pots

Slag Handling is expensive business—part of the cost of every ton of steel. But when you apply Johnston Corrugated Cinder Pots and Slag Handling Equipment you'll find their performance an important factor in keeping slag disposal at the lowest cost-per-ton of steel produced.

Every Johnston Corrugated Cinder Pot is engineered for its specific job. That's why they establish records for heat-hours of service life—why they are so economical for use in blast furnace or open hearth slag disposal operations.

Then, too, you'll find that our engineers are constantly developing and improving methods and equipment for more efficient slag handling. This continuing research is reflected in reduced slag disposal costs when you adopt Johnston Corrugated Cinder Pots and Slag Handling Equipment.

Tapping a 480 ton open hearth heat in two 250 ton ladles, the slag being handled by two 400 cubic foot Johnston Corrugated Cinder Pots

Don't forget that it pays to *keep your eye on what's new at Mack-Hemp.* Just write or phone and we'll show you how we can expedite your slag handling by installing this modern equipment.

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PITTSBURGH AND MIDLAND, PA.

ELWELL-PARKER PAPER LIFT TRUCK

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Battery Electric Trucks and EXIDE-IRONCLAD BATTERIES

The time-saving team that cuts handling costs

In more and more plants, management is finding the right answer to its material handling problem by using Battery Electric Trucks. Time is being saved—more tons per man, per hour. Handling costs have been cut as much as 50%. More storage space is being utilized by high tiering. All combine to effect substantial savings that help to offset increased manufacturing costs.

When electric trucks are powered with Exide-Ironclad Batteries, they keep on the job, all day long, lifting, hauling and stacking materials. The completely different construction of Exide-Ironclad Batteries results in (1) high power ability, (2) high electrical efficiency, (3) ruggedness and (4) exceptionally long life. Only Exide-Ironclad Batteries have these four essential characteristics.

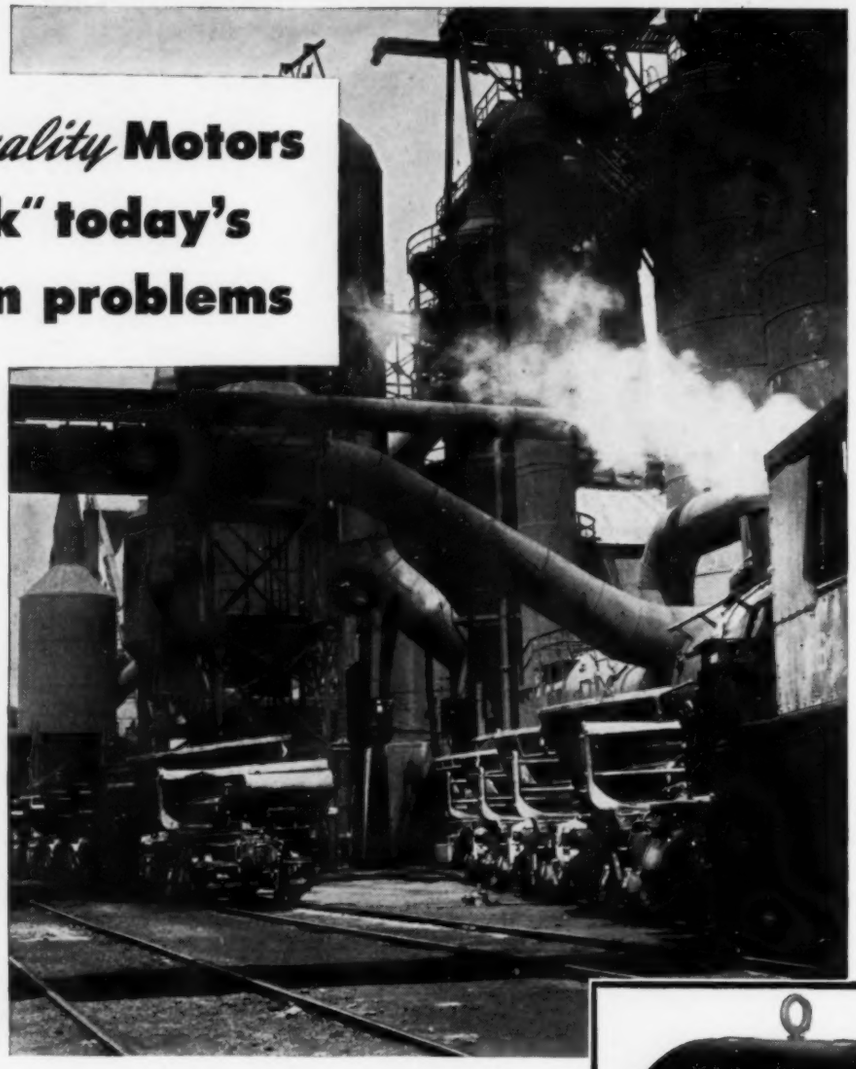
Speed up your material handling. Cut your handling costs. Put Battery Electric Trucks and Exide-Ironclad Batteries to work in your plant.

Write for further particulars and FREE copy of Exide-Ironclad Topics, which covers latest developments in material handling and shows actual case histories.

1888 . . . Dependable Batteries for 60 Years . . . 1948

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32 • Exide Batteries of Canada, Limited, Toronto

Wagner *Quality* Motors help "lick" today's production problems



In order to combat rapidly rising production costs, industry is placing greater emphasis on high-speed, economical production techniques. Down time is lost time—motor failures can prove more costly than ever before . . .

Wagner Quality Motors are famous for their dependability. They have the stamina to stand up under severe operating conditions—to stay on the job without frequent breakdowns—because they are made of highest quality materials and are engineered to do their job efficiently.

If you need motors that can help "lick" *your* production problems, whether large or small, consult the nearest of our twenty-nine branches. They are located in principal cities and are manned by experienced field engineers who will help you solve your motor application problems. Quick, convenient service facilities are available for users of Wagner Motors. Write for Bulletin MU-185 for information on the complete line of Wagner Quality Motors.

Wagner protected motor, tested and approved by Underwriters' Laboratories for Class 1 Group D and Class 2 Group G hazardous locations.

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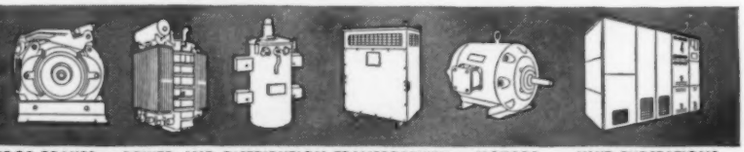
Consult Wagner Engineers on all Electric Motor Problems

Wagner Electric Corporation EST. WE 1891



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M48-12

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The use of Pittsburgh rolls for all rolling operations will result in "less cost per ton of steel rolled."

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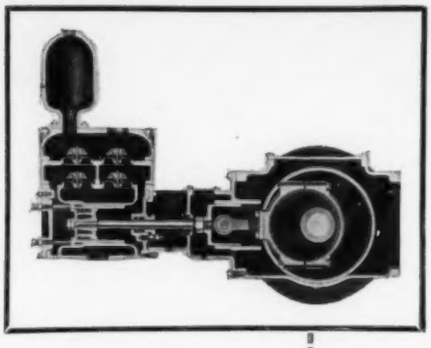
PITTSBURGH ROLLS

DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH 1, PENNSYLVANIA

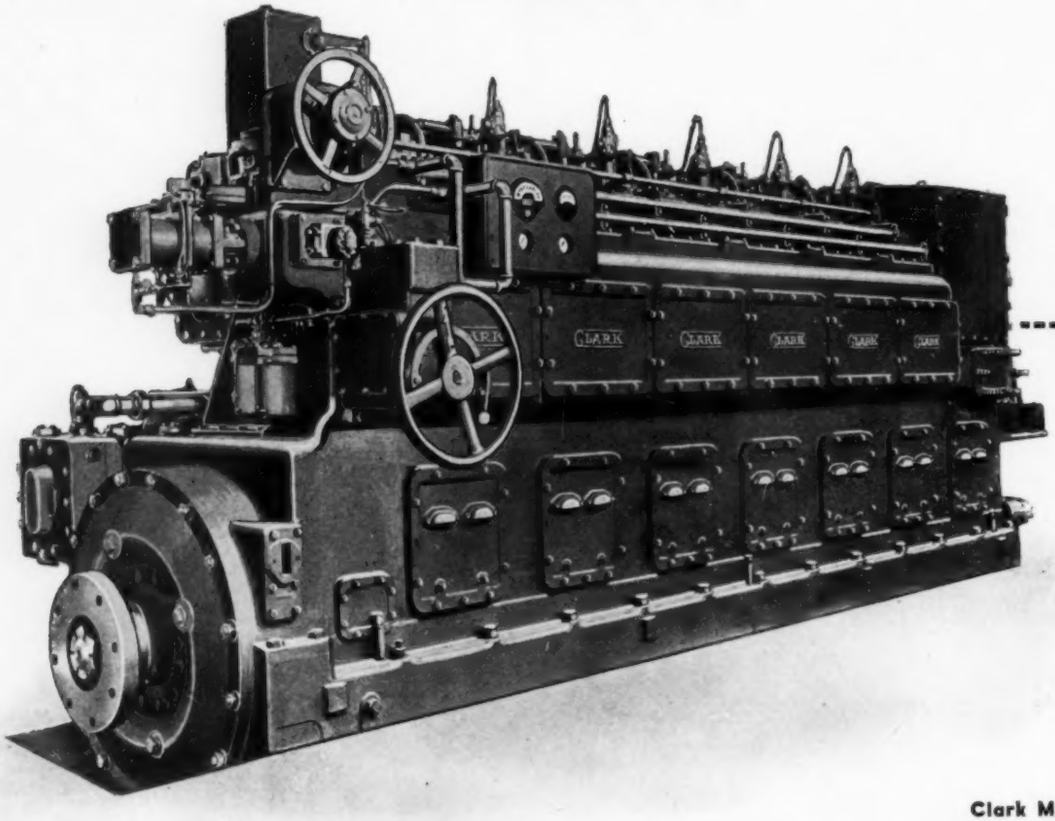
DURABLA

PUMP VALVE UNITS ARE STANDARD EQUIPMENT ON CLARK MARINE DIESELS...



Clark heavy duty marine Diesel Engines have, since the inception of this important design, utilized DURABLA PUMP VALVE UNITS in the built-in cooling water circulating pump. DURABLA valve units are installed in the pumps on Clark Type MD. Marine Diesels supplied for the U. S. Army S. T. Harbor Tugs, and many other installations are in equally essential postwar service.

From the pump valve standpoint, Diesel cooling water pumps represent a "tough" service. This is due to the high speeds needed in small pumps to supply the large volumes of cooling water required in continuous marine service, and the resulting high liquid velocity through the valves. DURABLA PUMP VALVE UNITS provide efficient and long time performance in all Diesel applications.



Clark Marine Diesel Engine Type MD.

Address DURABLA Engineering Department for Information and Bulletin: Reference 855

* Patent Numbers 2090486, 2117504

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SILICONE INSULATED MOTORS

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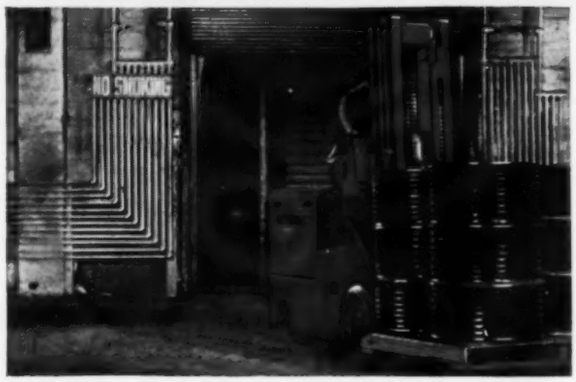
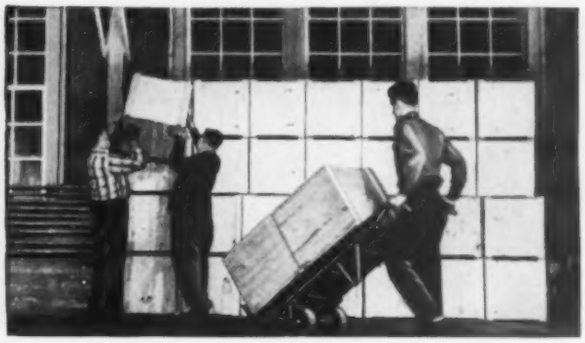


Motor Failure Means

Going Back TO THIS ⬇



Constant starting, stopping, reversing and overloading give an electric motor an awful beating — often cause overheating, which means motor failure, trucks out of service.

Automatic foresaw the demands which would be put on Skylift Electric Trucks, so gave you the protection of SILICONE MOTOR INSULATION. This is an exclusive silicone varnish and silicone lubricant that protects Skylift motors, even if overloaded, and even after exposure to temperatures of 300 to 400 degrees Fahrenheit.

This means no armature or field coil failure, no trucks laid up for motor repair, no interruption of Skylift's smooth, efficient money-saving material-handling operation. NO OTHER material-handling trucks offer this EXCLUSIVE feature!

Only Skylift Gives You High Pressure Hydraulic Lift!

With Automatic's exclusive patented design, using *high-pressure* hydraulics, you can *raise forks to maximum height of single lift,* before *increasing overall height of uprights.* Forks raise 67 *inches before uprights begin to extend!*

As you see by the pictures at the left, you get easy entry into box cars and other low clearance portals. You tier your product to maximum height without uprights jabbing into ceilings. The same Skylift also tiers up to 130 inches high. Only Automatic Skylifts offer you this double-duty money-saving feature, because ONLY Skylift Electric Trucks are equipped with HIGH PRESSURE Hydraulic Lift. Mail coupon.

Automatic is First with Most Great Features

1 **Caster** type steering axle, center pivoted and shock-proof. Compensates for uneven floor conditions. Provides easier steering, prevents transmission of road shock to steering wheel.

2 **Lift, tilt and drive simultaneously** or independently with easy fingertip and foot control regardless of load conditions. The only hydraulic industrial truck that does not sacrifice lift or tilt performance to accomplish this feature, because only Skylift has High Pressure Hydraulic Lift and Tilt.

3 **Full automotive type controls.** Brake pedal and foot accelerator same as a car. One lever controls lift and tilt, the other forward and reverse. NEW-matic controller gives smooth, timed automatic acceleration through all speeds.

4 **Air-cooled disk brake.** Mounted on end of motor where brake torque is least. This greatly prolongs life, gives greater braking surface, insures positive and smooth stopping.

MAIL COUPON ➤➤➤

Skylift ELECTRIC TRUCKS — Lighten LIFE'S LOADS

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DIV. OF THE YALE AND TOWNE MFG. CO.
47 W. 87th Street, Dept. H-8, Chicago 20, Ill.

( ) Send details on Automatic's Skylift Electric Trucks with High Pressure Hydraulic Lift and Silicone Insulated Motors.

( ) Have an ATCO Specialist make a free survey of our material-handling costs.

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By.....
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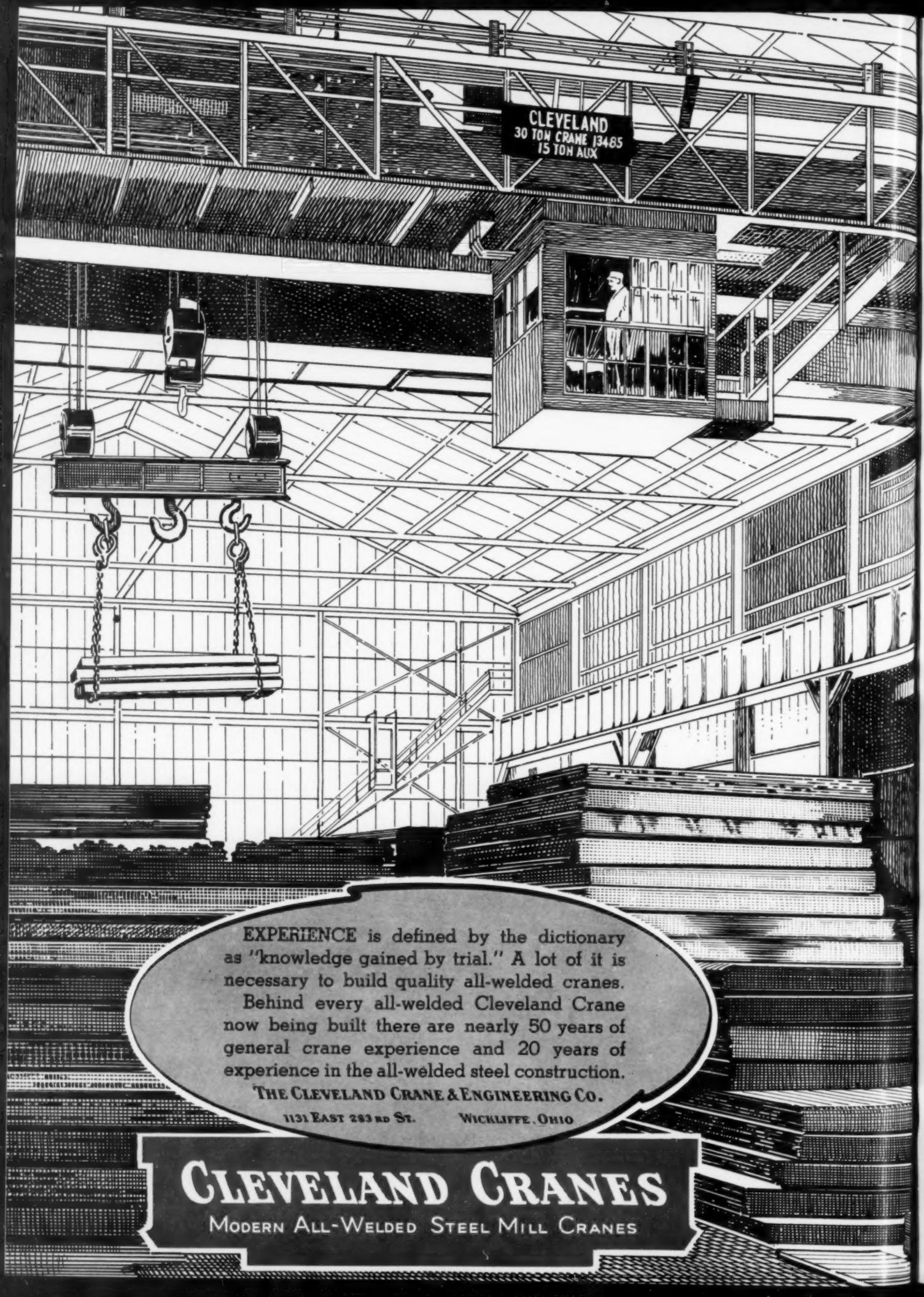
MANUFACTURERS OF THE FAMOUS TRANSPORTERS, TRANSTACKERS AND SKYLIFT ELECTRIC TRUCKS



EXPERIENCE is defined by the dictionary as "knowledge gained by trial." A lot of it is necessary to build quality all-welded cranes.

Behind every all-welded Cleveland Crane now being built there are nearly 50 years of general crane experience and 20 years of experience in the all-welded steel construction.

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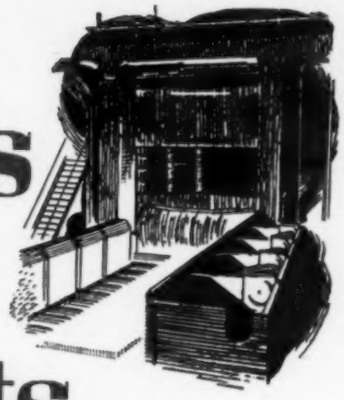
MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts



RECORD attendance marked the annual meeting of the American Iron and Steel Institute in New York, May 26–27. The following are excerpts from some of the addresses:

Dr. Charles F. Kettering, in the 1948 Schwab Memorial Lecture: Closely integrated and interdependent functions of the steel, automotive, oil and rubber industries preclude sudden revolutionary changes in their products, notwithstanding new discoveries. In an economy geared to mass production and distribution, new developments cannot immediately supplant present types without seriously disrupting industrial activities in many fields.

Steelmakers should not fall into the mental attitude of looking for a leveling-off or a let-down in demand. This attitude could lead to reluctance to expand facilities in line with the growing nation. Oil men declare they could produce more oil if they could get more steel to drill for it. The automotive industry feels it could have produced a couple of million more cars in the last year or more, if it could have obtained adequate steel supplies.

David F. Austin, vice president, United States Steel Corporation: Had there been no work stoppages or raw material shortages, 1946 and 1947 would have yielded an additional 20 million tons of finished steel products . . . equalling almost one-third of a full year's production. Added to actual production, this tonnage might well have brought supply and demand into balance.

There was not a single peacetime year from 1900 to 1939 during which the industry was called upon to operate as high as 90 per cent of capacity. There were but seven years in which the production rate exceeded 80 per cent; nine in which the rate was in the 70's; and ten more when the rate was between 60 and 70 per cent. Of the remaining eleven years, three were in the 50's, and the average for the other eight was 36.1 per cent.

A projection of the normal trend of per capita consumption for 1948 indicates a consumption of 565 pounds per person. Against it, set the figure of 846 pounds, the per capita productive capacity of the steel industry today. Based on the last 48 years, the normal trend line of steel consumption has risen at an average annual rate of 5.4 pounds per person, while the capacity to produce steel has increased at an annual rate of 8.2 pounds per person.

We have temporarily become the steel source for the whole peace-seeking world. In 1937 the United States accounted for 38 per cent of world production of steel, while in 1947 we produced more than 56 per cent.

Walter S. Tower, president, American Iron and Steel Institute: In tonnage of products shipped, 1947 was almost 20 million tons above the best previous non-war year. During the first quarter of 1948, output was approaching the figure which was reached in the all-out war effort of 1944. Even that wartime record would probably have been exceeded this year, if production had not been cut by a coal mine strike, with the resulting loss of nearly 2 million tons of ingots.

Shipments in 1947 were more than 40 per cent greater than the tonnage shipped in 1929, but the profits in 1947 were actually less than in the earlier year, and in buying power, only half as good.

The 145 million people in this country had more steel last year than was made in all the rest of the world, with its population more than 15 times the size of ours.

Annual steelmaking capacity as of January 1, 1948, was above 94 million tons of ingots. More capacity is being completed this year, and still more is planned to be available in 1949. By the end of next year, steelmaking capacity in this country will top 96 million tons. But in spite of increased capacity, there is real doubt whether the available supply of metallics would have permitted production of more than 90 million tons of steel in 1948, had there been no coal strike.

Programs of improvement and expansion which have been under way since fighting stopped are expected, when completed, to add some important finishing facilities and about 5 million tons of annual ingot capacity. Estimated total cost exceeds 1½ billions of dollars, or an average of $300 for each additional ton of steelmaking capacity. Ten years ago, the average investment per ingot ton for representative companies was about one-fourth that figure.

Senator Joseph J. Ball, of Minnesota: Public interest demands that unions and employers bargain on a local or single-employer basis, and not by industry-wide methods. If we permit industry-wide bargaining on an unrestricted basis, then industry-wide strikes are inevitable. In the public interest, no society can permit minority groups within it to destroy its essential fabric and hope to survive.

Representative Charles A. Halleck, House majority leader: The entire economic structure of the nation will feel the effects of the foreign aid program. Exports of steel to Europe should be held to a minimum. If the United States were to ship to Europe all of the steel which nations there have asked for, our people would have to make intolerable sacrifices.

Any program for harmonious public relations must be based primarily on recognition by both unions and management of the rights of the general public.

▲

FOR several weeks, the Park Lane Villa, a Cleveland hotel owned by the Brotherhood of Locomotive Engineers, was picketed by maids, members of the AFL Building Service Union, striking for a raise in their $28–$30 weekly wages. Alvanley Johnston, the engineers' chief, refused to meet them or AFL leaders, but advertised for non-union replacement. This is the same man who complains bitterly that his union is shackled by the presidential injunction calling off the railroad strike. Just another case of the shoe on the other foot.

▲

IF churches really got all the money they're credited with on income tax deductions, they could all declare a dividend.

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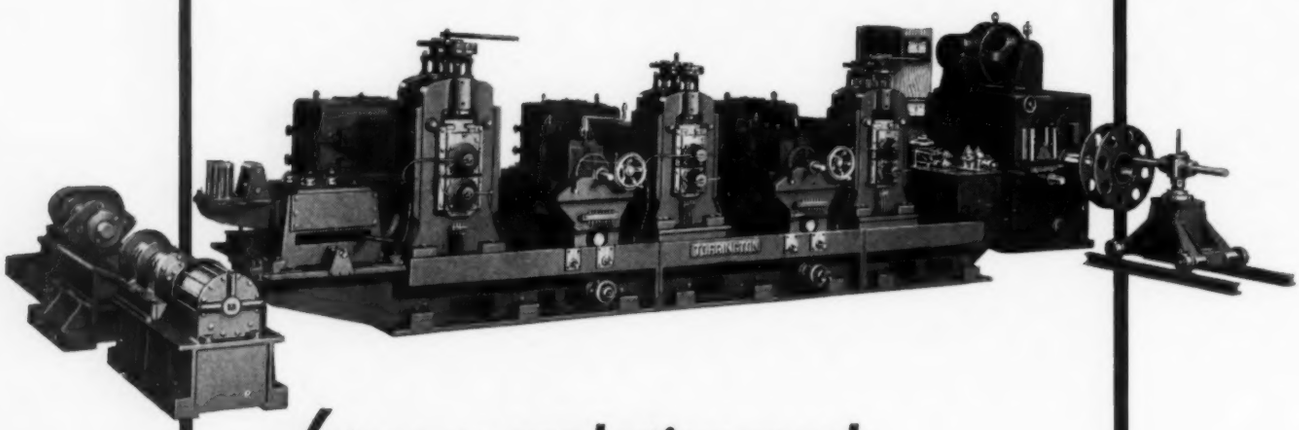

✓steps up production speeds

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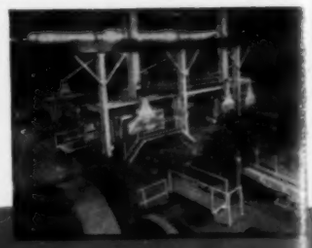

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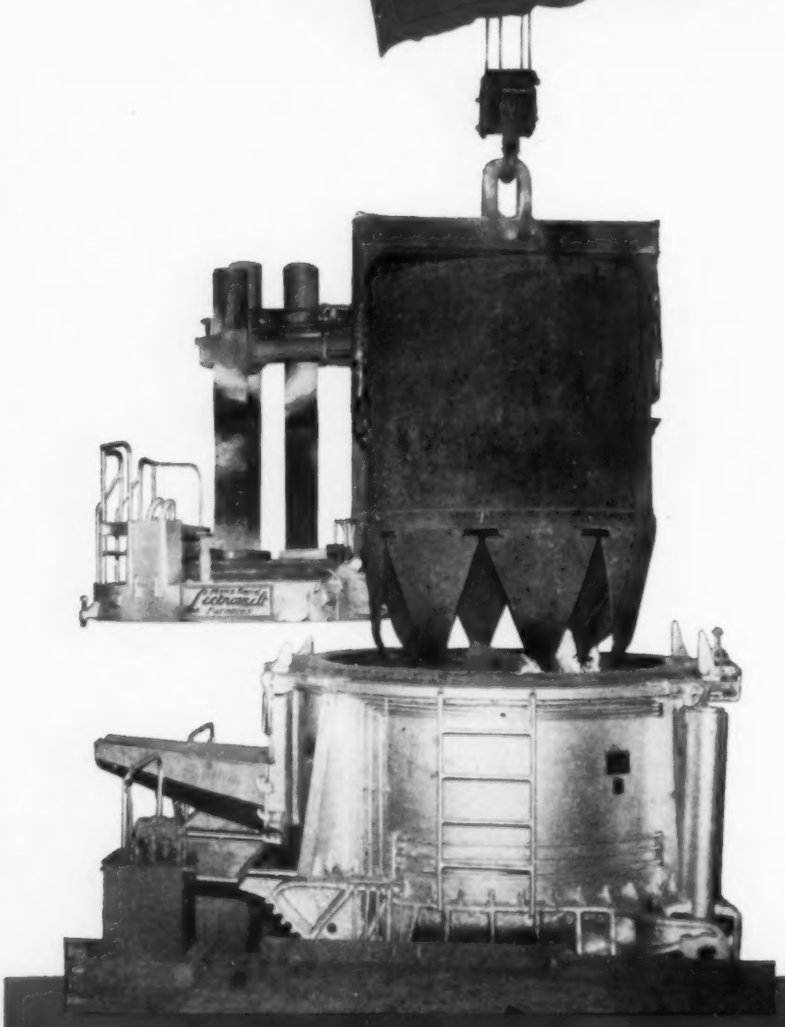

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Application of the Basic Principles of Rolling in Roll Design

By ROSS E. BEYNON, Superintendent
Roll Shop Department
Carnegie-Illinois Steel Corporation
South Works
Chicago, Illinois

ROSS E. BEYNON

. . . . with this review of rolling principles Mr. Beynon adds a sixth chapter to his previous comprehensive papers which dealt with bar mills, blooming and billet mills, structural mills, rail mills and rod mills . . . .

▲ ROLL design may be said to have started with the design of the first rolling mill. Patent papers and drawings indicate that considerable thought was devoted to the design of rolls long before Henry Cort built a rolling mill at Fontley, England in 1775 for which patents were granted him in 1783.

Flat rolling mills were first mentioned 280 years before Cort's time. Leonardo da Vinci, the famous artist and engineer, is reported to have rolled flat sheets of precious metals on a hand operated two-roll mill in the year 1495. These sheets were used in the manufacture of coins. Leonardo also had a design for a machine which was part rolling mill and part draw bench. These mills are illustrated in Drawing 1, Figure 1. The sketch of this last machine shows a fantastic arrangement of gearing and it probably was never built.

In 1565 a very small mill capable of being clamped on a work bench was built in Germany to roll a small H section of lead. Drawing 1, Figure 2 shows the essential parts of this machine. The process was part rolling and part drawing.

Soloman De Caus, a French inventor, gives a description of a mill consisting of two plain rolls. The rolls were turned by a hand crank. This mill was built in 1615 and rolled plates of lead and tin. See Figure 3.

Giovani De Branca, an engineer and architect of Rome, Italy, gives a description of a mill of his design, consisting of two rolls powered by gearing. The rolls were engraved for the rolling of embossed coins. See Figure 4.

John Payne of England was granted a patent in 1728 for a rolling mill in which the two rolls were to be grooved. Although this patent antedates Henry Cort's, it is doubtful if the mill was ever built.

In 1731 a small mill consisting of two rolls with round grooves was projected for rolling lead pipe on mandrels, reducing a pierced ingot of lead in several round grooves and then removing the mandrel. See Figure 5.

In France in 1752 a mill was erected for rolling iron bars of various cross sections, and it is said to have rolled iron molding from impressions on the surface of the upper roll.

In 1759 a patent was granted Thomas Blockley of England for rolling iron. The mill was to consist of two rolls to be turned as occasion might require.

Henry Cort's ideas were no doubt inspired by knowledge of these early mills and patents, but he can be given full credit for the first commercially successful puddle furnaces and grooved rolling mills; the success of which led to the rapid development of the rolling mill.

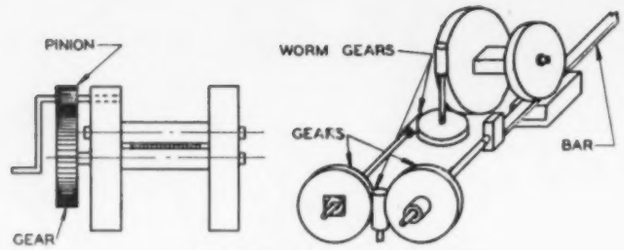
At first the rollings of these mills were confined to bars and plates until Clifford built a mill to roll horseshoes and nails in 1790. Among other new developments, angles were first rolled around 1819 and rails in 1820. Small tees were rolled in the period following.

Very little progress was made in shapes until Zores of France developed beam designs in 1848. Beams were rolled in France the following year.

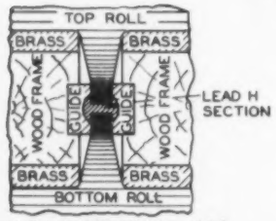
In 1867 a French rolling mill made some beams 43 in. in depth on a universal type beam mill, a forerunner of the present day universal beam mills.

From these pioneering efforts the modern rolling mills and roll designs of today were developed.

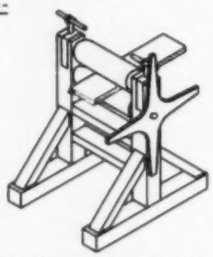
Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 22, 1947



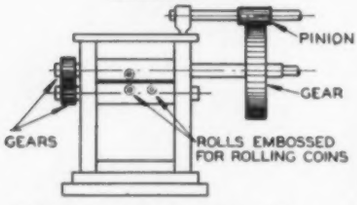
LEONARDO DE VINCI'S DESIGNS - 1495
FIGURE -1-



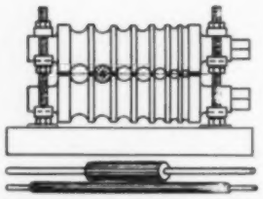
BUILT IN GERMANY - 1565
FIGURE -2-



SOLOMAN DE CAUS' DESIGN - 1615
FIGURE -3-



GIOVANI DE BRANCA'S DESIGN - 1629
FIGURE -4-



JOHN PAYNE'S DESIGN - 1728
FIGURE -5-

Drawing 1 — Rolling mills have been built for almost 500 years and some of the very early ones are shown in these figures.

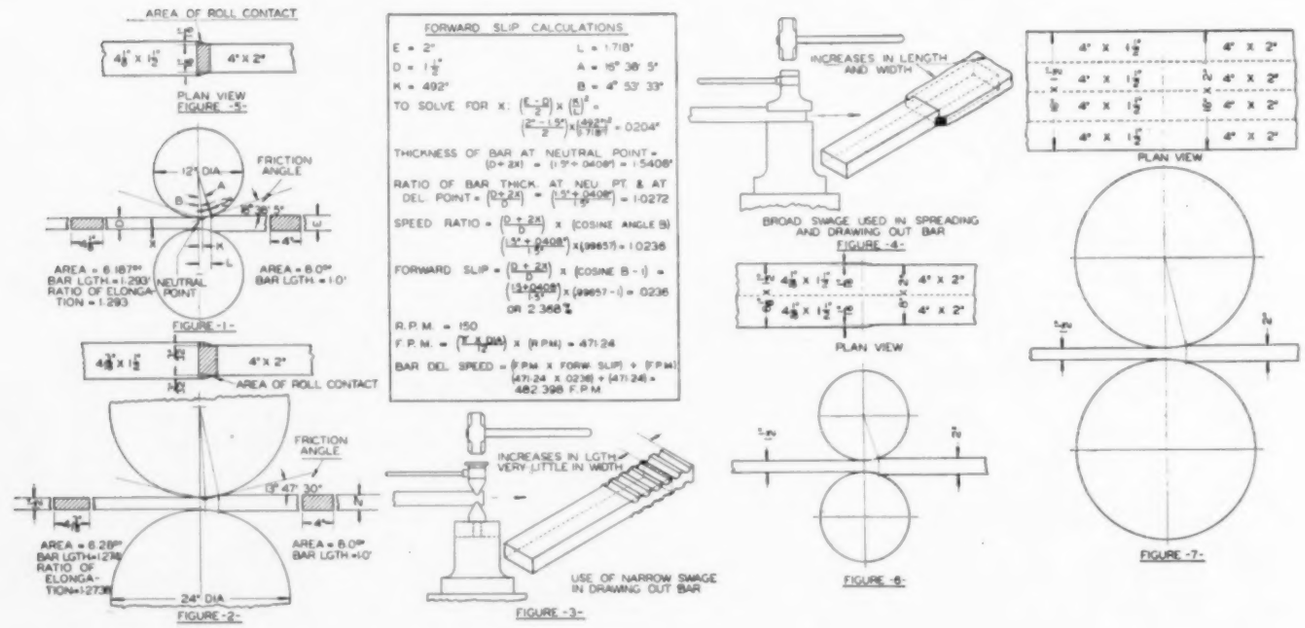
BASIC PRINCIPLES OF ROLLING

The basic principle of hot rolling is that hot metal being reduced in a pair of rolls elongates and spreads in proportion to the reduction accomplished. The spread of the piece is usually only a fraction compared to the elongation. There are some exceptions to this rule in the amount of spread and these exceptions will be explained later. The control and directing of this elongation and spread is fundamental in the art of roll design. The following discussion and the examples given are directly concerned with this basic principle of elongation and spread.

A simple example of elongation and spread is afforded in the reduction of one rectangle into another, as for instance a 4 in. × 2 in. × 12 in. long hot bar rolled on 12 in. diameter plain rolls at a speed of about 150 rpm. See Drawing 2, Figure 1. The bar is reduced ½ in. in this pass. In open hearth steel the spread in a case of this kind will be approximately ¼ of the draft or ⅛ in. The reduced bar then will be 4⅛ in. × 1½ in. The elongation will be proportional to the reduction in area, and is obtained by dividing the area of the pass by the area of the stock which in this example equals 1.293 to 1. This is called ratio of elongation and one foot of the stock multiplied by this figure will be the length of the bar after this pass or 1.293 feet.

At this point it should be pointed out that large diameter rolls spread the material more than smaller ones. For instance, if this same reduction as described above was done with 24 in. diameter rolls, Figure 2, more spread and less elongation would take place. The bar would spread approximately 3/16 in. and have a larger area than in the first example and, as the elongation is proportional to the reduction in area, there would be less elongation. One way of explaining this difference in spread would be to show that with the larger roll there is less extrusion of the metal than with the smaller one. Extrusion is faster delivery of the bar than that of the roll circumferential speed. Refer to Figure 1 of Drawing 2. The 12 in. diameter roll running at 150 rpm has a peripheral speed of 471.24 fpm while the delivery speed of the bar is 482.398 fpm as figured

Drawing 2 — These sketches illustrate the elongation and spread of hot bars.


AREA OF ROLL CONTACT
4" X 2"
PLAN VIEW
FIGURE -5-
12" DIA
FRICTION ANGLE
NEUTRAL POINT
AREA = 6.187"
BAR LGTH. = 1.293'
RATIO OF ELONGATION = 1.293
AREA = 8.0"
BAR LGTH. = 1.0'
FIGURE -1-
AREA OF ROLL CONTACT
24" DIA
FRICTION ANGLE
AREA = 6.28"
BAR LGTH. = 1.274'
RATIO OF ELONGATION = 1.2736
AREA = 8.0"
BAR LGTH. = 1.0'
FIGURE -2-
FORWARD SLIP CALCULATIONS
E = 2"
D = 12"
R = 492"
L = 1.718"
A = 15° 38' 5"
B = 4° 53' 33"
TO SOLVE FOR X:
THICKNESS OF BAR AT NEUTRAL POINT = (D + 2X) = (1.5" + .0408") = 1.5408"
RATIO OF BAR THICK. AT NEU. PT. & AT DEL. POINT = 1.0272
SPEED RATIO = (D + 2X)/D x (COSINE ANGLE B)
FORWARD SLIP = 0.0236
OR 2.368%
R.P.M. = 150
F.P.M. = 471.24
BAR DEL. SPEED = 482.398 F.P.M.
INCREASES IN LENGTH VERY LITTLE IN WIDTH
USE OF NARROW SWAGE IN DRAWING OUT BAR
FIGURE -3-
INCREASES IN LENGTH AND WIDTH
BROAD SWAGE USED IN SPREADING AND DRAWING OUT BAR
FIGURE -4-
PLAN VIEW
FIGURE -6-
4" X 1½"
4" X 2"
PLAN VIEW
FIGURE -7-

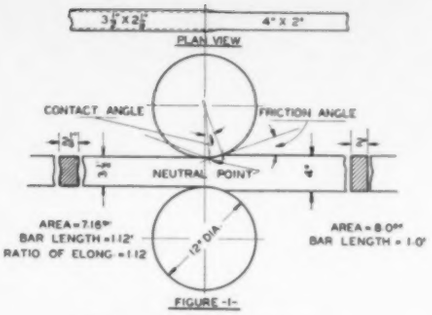


FIGURE -1-

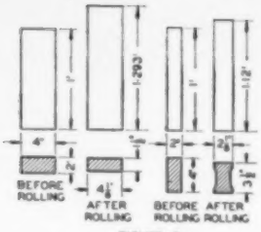


FIGURE -2-

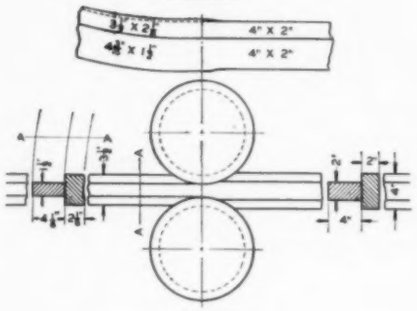


FIGURE -3-

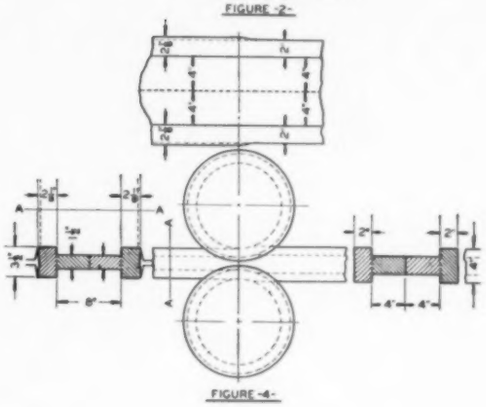


FIGURE -4-

Drawing 3 — This sketch illustrates the spread of hot bars in the vertical position.

by the formula shown. The 24 in. diameter rolls shown in Figure 2 with the same reduction and same peripheral speed would send the bar out of the rolls somewhat slower owing to greater spread, a lower ratio of elongation, and less extrusion.

The larger diameter rolls have a greater area in contact with the bar than the smaller diameter rolls as may be seen by referring to the hatched areas of the plan view of the 4 in. × 2 in. bars. The broader area of bar contact with 24 in. diameter rolls has an effect much the same as when a blacksmith using a broad swage elongates and spreads a hammered bar. When he intends to elongate only, he uses a narrow pointed swage which corresponds to the small diameter rolls. Figure 3 of Drawing 2 shows the drawing out of a bar using the narrow swage and Figure 4 shows the drawing and spreading effect on a bar when using the broad swage.

In considering extrusion, sometimes called forward slip, with the knowledge that a large diameter roll gives less extrusion than a small diameter roll and that the small diameter roll gives less spread than the larger roll, it is obvious that the greater the forward slip, the less the spread. In other words, the forward pull of the bar restricts spread to a certain extent, and the greater the pull, the less the spread in proportion. This, then is the logical explanation of the greater spread obtained from large diameter rolls.

The spread of fairly narrow width bars such as shown in the example is approximately ¼ of the total draft. Bars of greater width, however, would not always spread ¼ of the draft. Figure 5, Drawing 2, shows a plan view of the 4 in. × 2 in. bar being rolled in the 12 in. diameter rolls. Note that the spread of ⅛ in. is divided 1/16 in. on each side.

Figure 6, Drawing 2 shows a bar of 8 in. width by 2 in. thickness being rolled. In this case the spread is still only ⅛ in. or slightly less. If the 8 in. bar is considered as two 4 in. bars side by side as indicated by a dotted line, it will be apparent that there could be no spread where the dotted line is, because the two sides of the bar being together would oppose each other in spreading at this point and the only spread would be on the outside edges.

Carrying this thought still further, consider a 16 in. × 2 in. bar being rolled as indicated in Figure 7 of Drawing 2. Dotted lines divide it into four parts, each one 4 in. × 2 in. As the two center bars and the inside

Drawing 4 — Various types of passes are here shown.

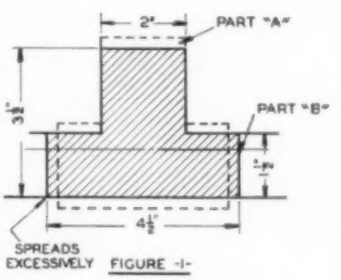


FIGURE -1-

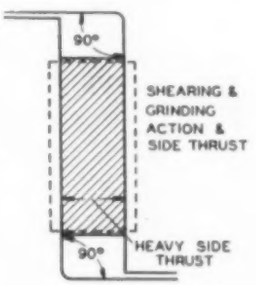


FIGURE -4-

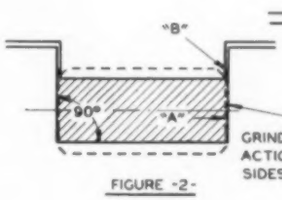


FIGURE -2-

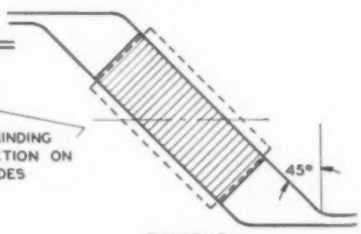
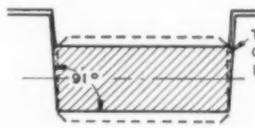


FIGURE -5-
DIAGONAL PASS



PROPER TYPE OF PASS
FIGURE -3-

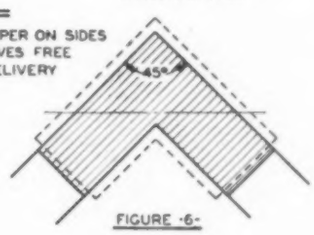


FIGURE -6-

parts of the two outside bars could not spread, being opposed to each other, the only spread could be on the outside edges. However, the pull of the elongation of the center bars and the inside parts of the outer bars is now so great that the outer edges are drawn along and there is little or no spread at these points.

It is a generally known fact that wide bars spread little, if any, while narrow ones spread a certain percentage of the draft and this is the explanation.

Next consider what happens when a 4 in. × 2 in. bar is drafted in plain rolls in the vertical position. See Drawing 3, Figure 1. With the same ½ in. draft as was taken in the horizontal position there is very little elongation. The metal is upset on top and bottom and there is little reduction in area. The reduced area is 7.16 square inches, which gives an elongation factor of 1.12. Only the top and bottom of the bar experience reduction; the center remains practically unchanged, and will elongate only as drawn along by the top and bottom. Since the center part has the greatest area and

Drawing 5 — The three-high plate mill shown has top and bottom rolls of 38 x 132 in. and a middle roll of 22 x 132 in.

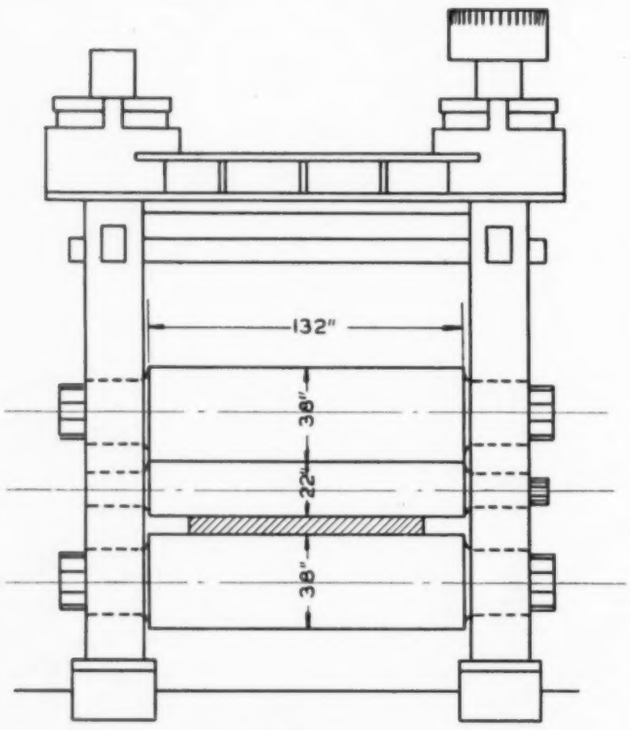
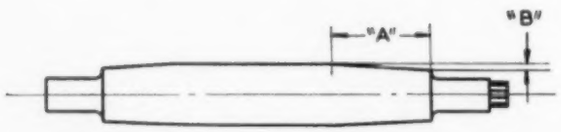
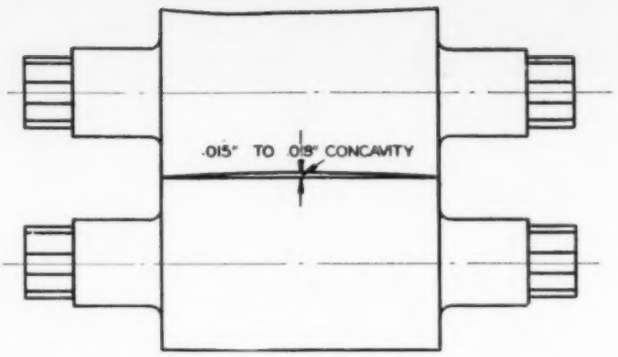


FIGURE -1-
132" 3-HI PLATE MILL



FIRST TAPER	A = 40"	B = .064"
SECOND "	A = 45"	B = .081"
THIRD "	A = 45"	B = .099"
FOURTH "	A = 46"	B = .115"
FIFTH "	A = 46"	B = .125"

FIGURE -2-



SHEET MILL ROLLS
FIGURE -1-

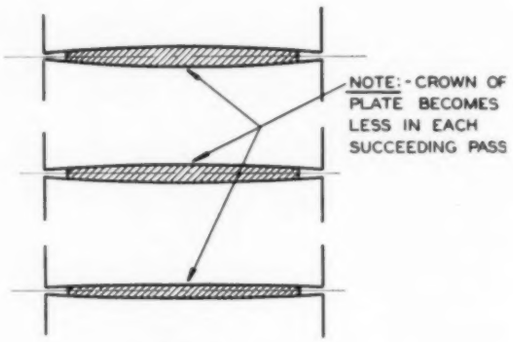


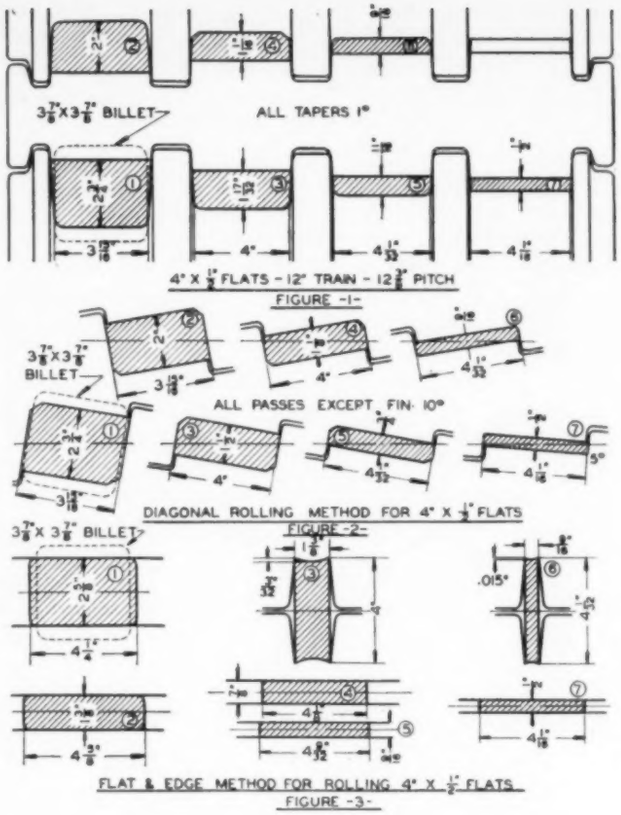
FIGURE -2-
FLAT PRODUCT FROM CONTINUOUS & SEMI-CONTINUOUS MILLS

Drawing 6 — In the hot sheet mill, allowances for the expansion due to the heat retained in the rolling body must be used in machining the roll diameter.

is unaffected by the draft, it resists elongation. Under this condition the top and bottom, being unable to elongate freely, spread more than they elongate. Such elongation as takes place, will be greater at the top and bottom as compared to that of the center of the bar, as shown in Figure 1. Edging passes are therefore, of little value for reduction purposes.

In the first example one foot of a 4 in. × 2 in. bar after rolling became 1.293 feet long. The 4 in. × 2 in. bar rolled in the vertical position became 1.12 feet long after passing through the rolls. Refer to Figure 2 of Drawing 3 which shows these bars before and after elongating.

If the two bars are joined together in the manner shown in Figure 3 of the same drawing and given the same drafts as they were given singly, they could not come out of the rolls the same length as when they were drafted separately. The plan view of Figure 3 shows that the bar, if free to camber, would come out of the rolls curved as shown. The vertical part having the least elongation would resist being stretched to the length of the flat section. The only way the flat section could roll out to its full length would be to come out in a curved form as shown, bending the upright section at the same time. The flat part in this case would be prevented from elongating to its full extent by the resistance to elongation of the upright part, and the upright part would be stretched to a certain extent. The flat part not being able to reach its full elongated


3⅞"X3⅞" BILLET
ALL TAPERS 1°
4" X ⅜" FLATS - 12" TRAIN - 12⅜" PITCH
FIGURE -1-
ALL PASSES EXCEPT FIN. 10°
DIAGONAL ROLLING METHOD FOR 4" X ⅜" FLATS
FIGURE -2-
.015"
FLAT & EDGE METHOD FOR ROLLING 4" X ⅜" FLATS
FIGURE -3-

Drawing 7 — This drawing shows various methods for rolling flats.

length spreads more than the ¼ in. per inch of vertical reduction. The volume of the rolled part is the same as the volume of the stock and the part that does not go into length must go into spread.

Next we will consider two bars of the same shape as just described, joined together as shown in Figure 4, Drawing 3, and given drafts of ½ in. as indicated.

In this case the two parts joined together would deliver from the rolls in a straight line, but the center as shown by the dotted line will elongate the most. The plan view as shown in Figure 4 shows the two vertical ends still resisting elongation, holding the parts adjacent to them back. A heavier drafting of the center parts would cause a buckled condition in this part.

Next view the effect of rolling the parts as shown in Figure 1, Drawing 4. In this case the center part "a" would have very little elongation, while the part "b" would elongate and spread. Part "a," because of less elongation than part "b," would resist being stretched to an equal length with part "b;" consequently part "b" would spread more than if rolled without part "a."

At this point it is well to point out some pass forms and some advantages and limitations inherent in them. See Figure 2, Drawing 4. Any attempt to roll the 4 in. × 2 in. slab to a 1½ in. thickness in a pass of this kind would result in a rough delivery of the bar from the rolls, because the straight sides "a" would grip the sides of the bar tightly and cause a grinding action on the sides, with the likelihood of shearing and an overfill at part "b." A pass of this kind should have a taper as shown in Figure 3 of the drawing, at least ½ to 1 degree in order that the bar may be delivered properly. Next consider Figure 4, which shows the collars on two rolls in a vertical position, operating on the bar. This also is an impractical pass, as the bar would have a tendency to shear here and, in addition, would create a tremendous side thrust.

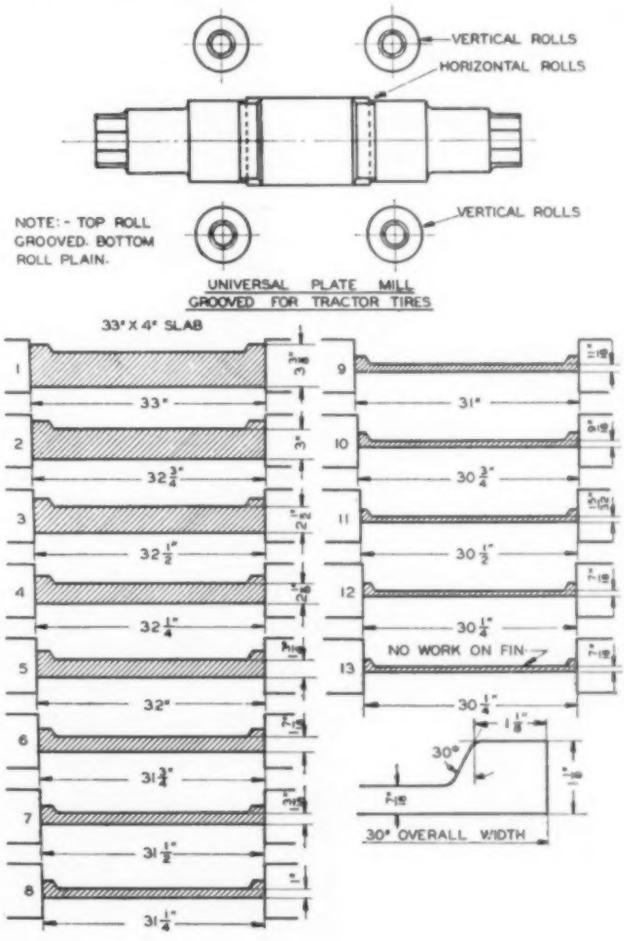
A drafting as shown in Figure 5 is practical with the angle of the rolls 45 degrees, although not done on a bar of this type. If two bars were joined on the ends as shown in Figure 6, we would have the same type of drafting as used on the finishing passes of angles. Drafting of the kind shown in Figure 5 is usually used only when that member is part of some section.

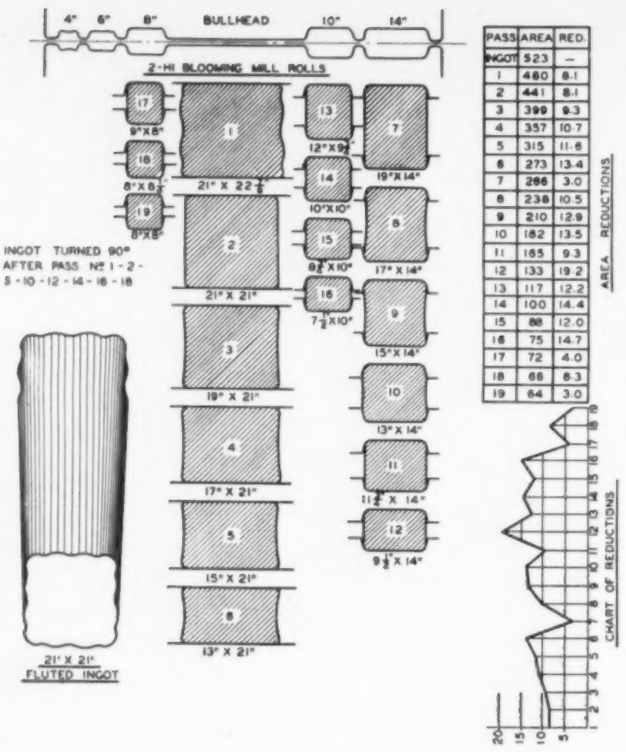
FLAT PRODUCT

Rolling as was shown in Drawing 2, Figure 1, is only used for sheared plates, because there is no means, except shearing, for accurately regulating the width.

The rolling of wide plates furnishes some examples of the effects of unequal elongation. In past years most of the wide plates were rolled on two-high or three-high plate mills. In this country three-high mills were the most popular. These mills had large diameter top and bottom rolls and smaller middle rolls. Refer to Drawing 5, Figure 1, which shows a 132 in. three-high plate mill stand. Top and bottom rolls were 38 in. × 132 in. and

Drawing 8 — This 30 in. universal plate mill has been grooved to roll tractor tires.




4" 6" 8" BULLHEAD 10" 14"
2-HI BLOOMING MILL ROLLS
INGOT TURNED 90° AFTER PASS Nº 1 - 2 - 5 - 10 - 12 - 14 - 16 - 18
21" X 21" FLUTED INGOT
AREA REDUCTIONS
CHART OF REDUCTIONS

PASS	AREA	RED.
INGOT	523	—
1	480	8.1
2	441	8.1
3	399	9.3
4	357	10.7
5	315	11.8
6	273	13.4
7	266	3.0
8	238	10.5
9	210	12.9
10	182	13.5
11	165	9.3
12	133	19.2
13	117	12.2
14	100	14.4
15	88	12.0
16	75	14.7
17	72	4.0
18	66	8.3
19	64	3.0

Drawing 9 — This drawing shows the drafting of a 21 x 21 in. ingot to an 8 x 8 in. bloom.

the middle roll 22 in. × 132 in. The mill was non-reversing. The top roll had a screwdown and the plates were entered between middle and bottom rolls first, then back through middle and top rolls. The middle roll was backed up by bottom and top rolls alternately.

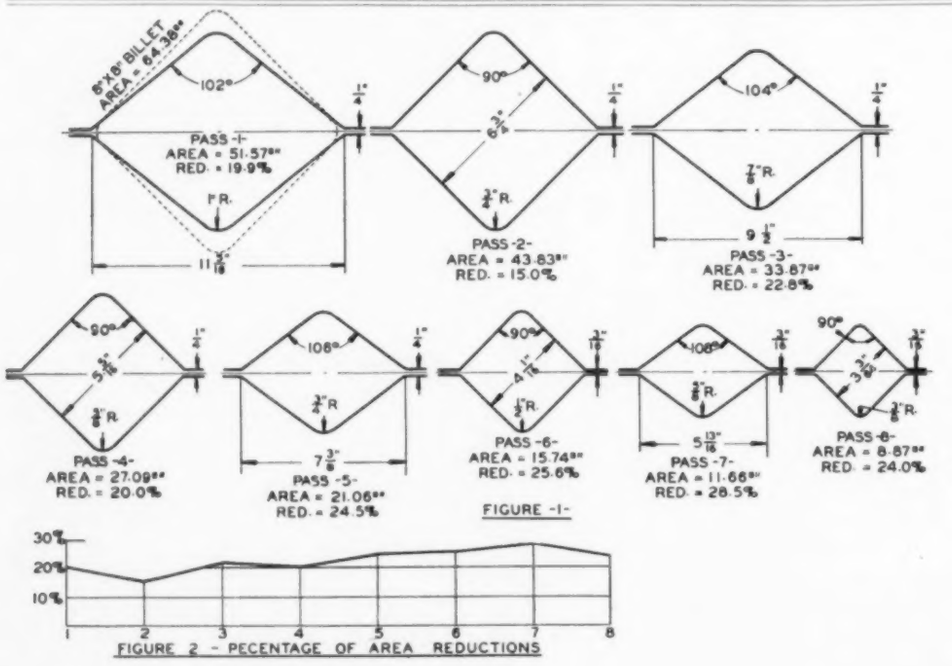
The usual procedure in this mill was to enter a slab 36 in. to 42 in. in width with varying length broadside, and roll forth and back until the desired finished width was obtained, plus 3 or 4 inches for side shearing. Then the plate was turned back again and rolled in the lengthwise direction to thickness and length.

In a mill such as this there is considerable spring in the rolls, and they also bend in the center. Thus, the plate is thicker at the center than on the sides, and when the plate is down near the finished size, some plates buckle on the sides, owing to the elongation of the thin edges being greater than the elongation of the thicker center. To counteract this effect, the middle roll of mills of this kind is turned or ground so that it is thicker in diameter in the center than on the ends. See Figure 2 of Drawing 5. This counteracted the effect of the roll bending, though even at the best, the centers of finished plates were ten to fifteen thousandths thicker than on the sides, and there was also considerable buckle on the sides. Most of this buckle was taken out by a roller leveler as the plate was run through it while still hot.

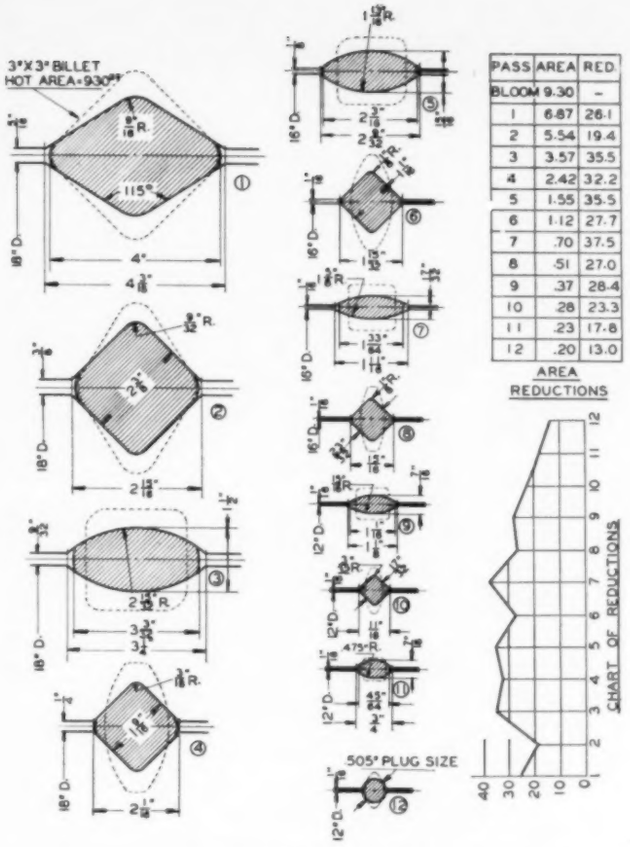
It was customary to keep the top and bottom plate rolls in for a week's rolling, and during this time these rolls wore away at the center, increasing the crown in the plate. As this was not desirable, nearly every day a new middle roll was put in with a greater roll-crown, until at the end of the week five middle rolls had been used with a pair of top and bottom rolls. All of the rolls were then removed and dressed.

These difficulties with crowned and buckled plates led to the adoption of the four-high mill, which has less spring than a two or three-high mill.

In contrast to the bending of the long plate mill rolls, we have the problem of the short body, big diameter, sheet mill rolls. Such rolls are run without water on the bodies. Drawing 6, Figure 1 shows a pair of sheet mill rolls. Since rolls of this kind are run without water, the heat is retained in the roll body and the center of the roll, not being able to dissipate the heat as well as the ends, expands more than the ends and causes the sheets to be thinner in the middle than at the edges. This means more elongation in the center than at the edges which causes buckles in the center. To counteract this, one of the two rolls is turned smaller in diameter


6"X8" BILLET AREA = 64.36"
PASS -1- AREA = 51.57" RED. = 19.9%
PASS -2- AREA = 43.83" RED. = 15.0%
PASS -3- AREA = 33.87" RED. = 22.8%
PASS -4- AREA = 27.09" RED. = 20.0%
PASS -5- AREA = 21.06" RED. = 24.5%
PASS -6- AREA = 15.74" RED. = 25.6%
PASS -7- AREA = 11.66" RED. = 28.5%
PASS -8- AREA = 8.87" RED. = 24.0%
FIGURE -1-

Drawing 10 — This drawing shows the passes to reduce an 8 x 8 in. bloom to a 3 x 3 in. billet.



PASS	AREA	RED.
BLOOM	9.30	-
1	6.87	26.1
2	5.54	19.4
3	3.57	35.5
4	2.42	32.2
5	1.55	35.5
6	1.12	27.7
7	.70	37.5
8	.51	27.0
9	.37	28.4
10	.28	23.3
11	.23	17.8
12	.20	13.0

Drawing 11 — This drawing shows the passes to reduce a 3 x 3 in. billet to a ½ in. round.

in the center than on the ends. The rolls must then be heated up to permit good sheets to be rolled.

When continuous and semi-continuous mills were put in use for long lengths of sheets, strip and plates, uneven elongations in the flat product resulting from the uneven thickness became a serious problem.

One of the inventors of the continuous process of rolling thin flat material bases some of his claims on the shape and cross-section of the piece he obtains as it emerges from the rolls. The shape has less convexity in the center of each succeeding pass, the object being to have even elongations in each pass, thus freeing the piece from buckle. See Drawing 6, Figure 2.

The rolling of ingots in blooming rolls and the rolling of flats, sheet bar, skelp, plates, etc., are all tied in with the designs shown by Drawing 2, Figure 1.

When it is desired to roll flats in the flat position only, it is necessary to provide some means of controlling the spread and regulating the width of the bars. The most commonly used pass which will do this is the tongue and groove design. See Drawing 7, Figure 1. As has been previously shown, the sides of such a pass, cannot be 90 degrees with the axis of the rolls because of the tight gripping action of such a pass on the sides of the bar. Hence, the sides of the pass must be tapered, and the greater the taper the less the grip. Also, with a small degree of taper the grinding action of the delivering bar will cause side wear and it takes a heavy reduction in dressing to restore the pass to the original width. On the other hand, too much taper will not be conducive to a square edge on the bar. In the design shown a 1 degree side taper was used. This design was from a 12 in. diameter hand bar mill.

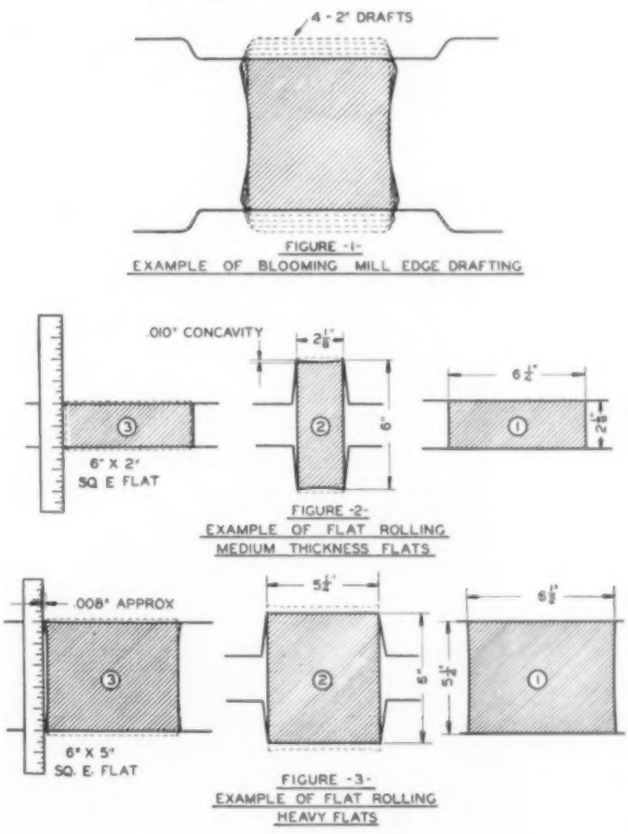
As the tongue and groove pass wears considerably and dressing to width causes considerable roll reduction, it is not too popular. Another form of pass which is better in some respects than the tongue and groove is the diagonal pass. See Drawing 7, Figure 2. This type of pass can be dressed to the original width with a comparatively light roll reduction, and also has the merit of giving some rolling action on the edge. The disadvantages are a twisting delivery and a side thrust on the rolls. These two designs are rarely seen in sizes over 20 in. As universal plate mills roll products from as narrow as 6 in. up to almost any width within the limits of the mill and the vertical rolls of the universal mills regulate the width, there is little use for the tongue and groove or the diagonal design for any but the smaller sizes.

The most commonly used method for rolling flats of small and medium size is the flat and edge design shown in Drawing 7, Figure 3, which has two or three flat passes to one edging pass. This design, wherein bars are edged in a vertical pass, is commonly used on bar mills requiring a variety of sizes to be produced from the same passes.

TRACTOR TIRE

Drawing 8 shows a sketch of a universal plate mill roll stand, together with sketches of a 30 in. tractor

Drawing 12 — Typical examples of spread are here shown.



tire rolled on this mill. The tire has beads on the end more than twice the thickness of the plate itself. The top roll is the only one grooved and, as this is a reversing mill, all the passes are put through this set of rolls. The stock is a slab 33 in. wide, and 4 in. thick.

In this kind of rolling there can be no proportionate reductions between web and bead from pass to pass in the vertical direction, but it is necessary to have these proportionate reductions in order that the elongation of the web and the beads will be fairly even.

It has been noted that edge work on bars has an upsetting effect. In rolling the tractor tire section advantage is taken of the upsetting effect by having extra side work for the vertical rolls to perform, and the upset edge of the plate furnishes the extra draft required for the bead. Thus, a feature that is detrimental in many sections is used to advantage in producing the tire section.

DRAFTING

The drafting of steel does not follow a progressively increasing or decreasing pattern. In looking over graphs of drafting practice for various sections it would seem that regular drafting was the exception rather than the rule.

Gradual increased reductions in inches from the finishing pass toward the starting section are the rule for most sections, but percentages of reduction rarely follow a definite pattern.

The reasons for gradually increased drafts in inches from the finishing pass up are many. Light reduction on the finishing pass gives correspondingly light wear on the rolls, which permits large tonnages to be rolled before the pass is worn out. The leader is also drafted lightly. The theory is that if bars out of the leader pass were rough they would cause more wear on the finishing rolls. From the leader back a gradual increase in draft is given. As the bars become longer, they also are colder and lighter drafts are necessary to prevent roll breakage.

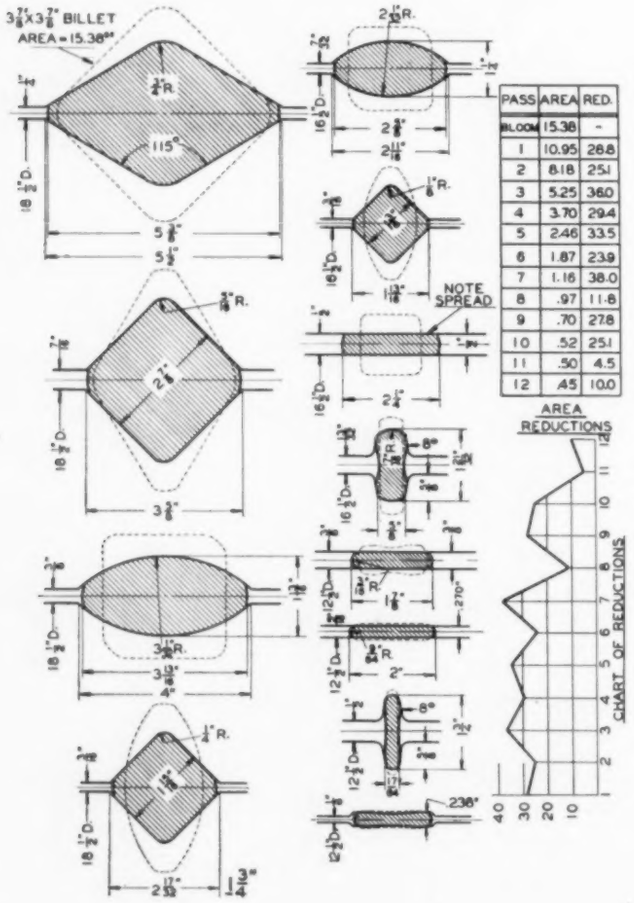
The finished material must have a good smooth appearance, and the hardest rolls which can be turned to the smoothest surface are used in the finishing stand. These rolls, while hard, are not strong, and heavy drafts cannot be taken safely on them. The heaviest drafts must necessarily be reserved for the earlier passes where the rolls are made of stronger material.

In the rolling of ingots on the blooming or slabbing mill, the steel is usually drafted lightly until the ingot skin as cast has been toughened by rolling, and then the drafts are increased. The limiting factors are roll strength, pass design, and an arc of contact with the piece which will readily pull the ingot into the rolls.

The following drawings show some examples of drafting from the ingot down to the finished bar and show the irregularity of the area reductions.

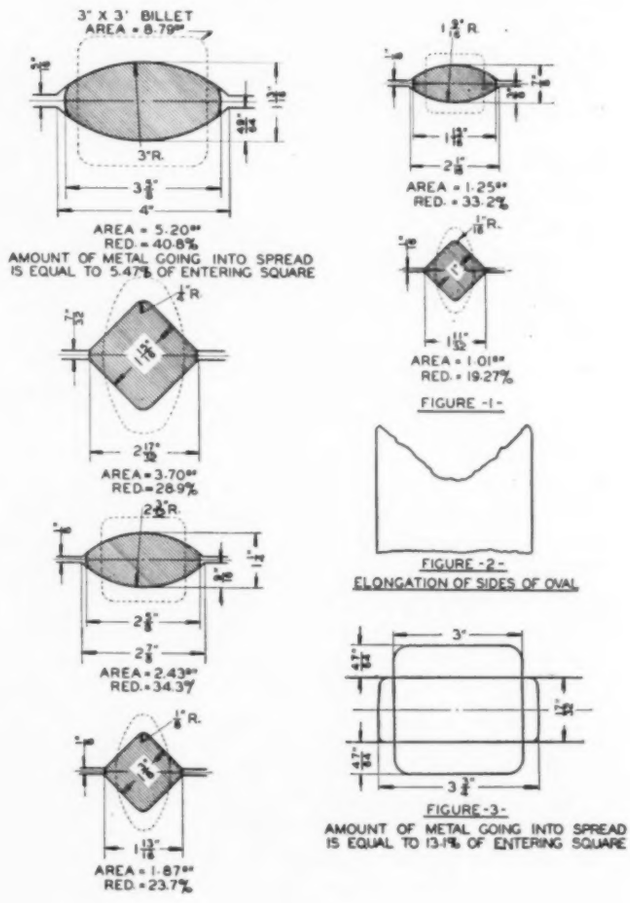
Drawing 9 shows passes on a 40 in. blooming mill

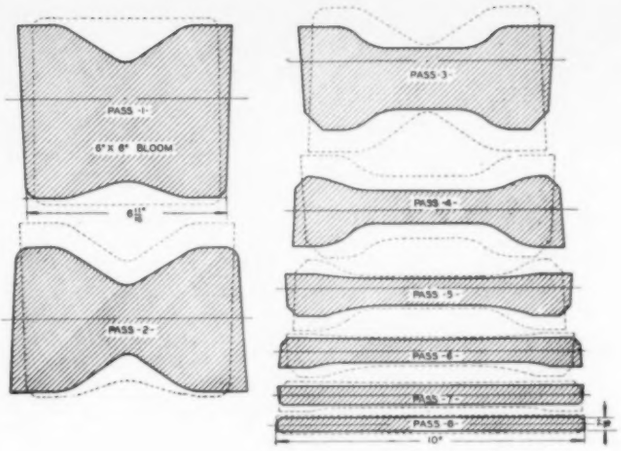
Drawing 13 — In this pass schedule, a 3⅞ in. billet of chrome vanadium steel is rolled into a 1¾ in. concave round-edged spring.



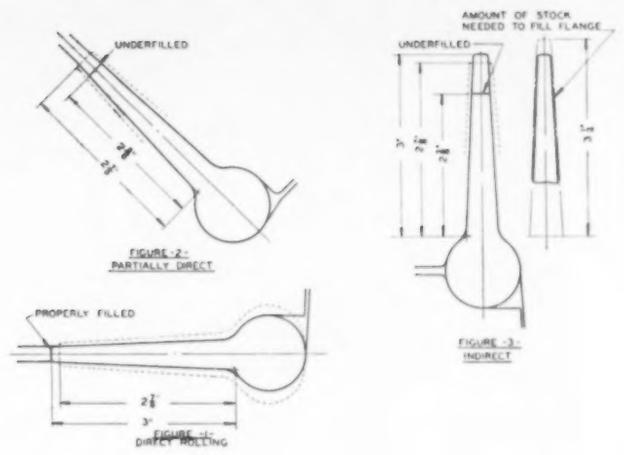
PASS	AREA	RED.
BLOOM	15.38	-
1	10.95	28.8
2	8.18	25.1
3	5.25	36.0
4	3.70	29.4
5	2.46	33.5
6	1.87	23.9
7	1.16	38.0
8	.97	11.8
9	.70	27.8
10	.52	25.1
11	.50	4.5
12	.45	10.0

Drawing 14 — Oval and square passes are shown here.





Drawing 15 — The passes shown favor excessive spread with relatively small elongations.



Drawing 16 — The drafts shown are illustrative only and show the differences between direct and indirect rolling.

reducing a 21 in. × 21 in. ingot to an 8 in. × 8 in. bloom and a graph of the percentage reductions.

Drawing 10 shows diamond billet passes reducing an 8 in. × 8 in. bloom to a 3 in. × 3 in. billet, together with the reductions.

Drawing 11 shows a 3 in. × 3 in. billet being reduced to a ½ in. round in a bar mill and the reductions expressed as percentages.

CONCAVE PASSES

The drafting of ingots furnishes an outstanding example of the type of drafting, previously shown on Drawing 3, Figure 1, where the material is upset on the surface which contacts the rolls and is stretched or remains unaffected in the center. Refer to Drawing 12, Figure 1. This shows a rectangular 28 in. × 38 in. ingot being rolled on edge in a plain bullhead pass after having been lightly drafted on all sides. The 2 in. drafts per pass which are being taken do not affect any part of the ingot except the surface. As the greatest part of the cross sectional area of the ingot is not affected by the draft, it cannot elongate except as it is stretched. Therefore, the center area holds back the upper and lower surfaces, which then spread excessively and assume the shape shown in the drawing.

Other examples of this rolling action are found in the rolling of thick flats. Refer to Figure 2 in Drawing 12. This shows a 6 in. × 2 in. square edge flat being finished on a 16 in. mill in plain flat rolls. The leader, as shown, is an edging pass with a concave edge of 0.010 in. With the ⅛ in. draft given in the finishing pass, this concave edge spreads enough in the center so that the sides of the bar are square.

Figure 3 in this drawing shows a 6 in. × 5 in. square edge flat finished on the same 16 in. mill. The edging pass which is 5¼ in. thick does not have any concavity and yet, with a ¼ in. reduction in the finishing pass, the sides are slightly concave. If they had to be absolutely square, it would require a slight convexing of the leader pass to produce the square side. As in the case of the ingot, the draft given is not sufficient to affect the center part and its resistance to elongation causes the upper and lower parts of the bar to spread.

SPREAD OF METALS

Earlier in the discussion open hearth steel was said to spread ¼ of the draft in the average sizes. This is true for the average grade of open hearth steel in sizes of 10 to about 60 square inches of area with drafts of about 20 to 25 per cent. There are cases where heavy reductions on small bars will cause a spread in excess of the ¼ in. per inch of reduction. Other materials also spread differently than open hearth steel. Bessemer steel for instance, does not spread as much as open hearth steel. There are also grades or types of steel which spread considerably more than either plain carbon open hearth or bessemer, such as some alloy steels, stainless, and spring steel grades. Roll diameter and size of bars also have an influence on spread.

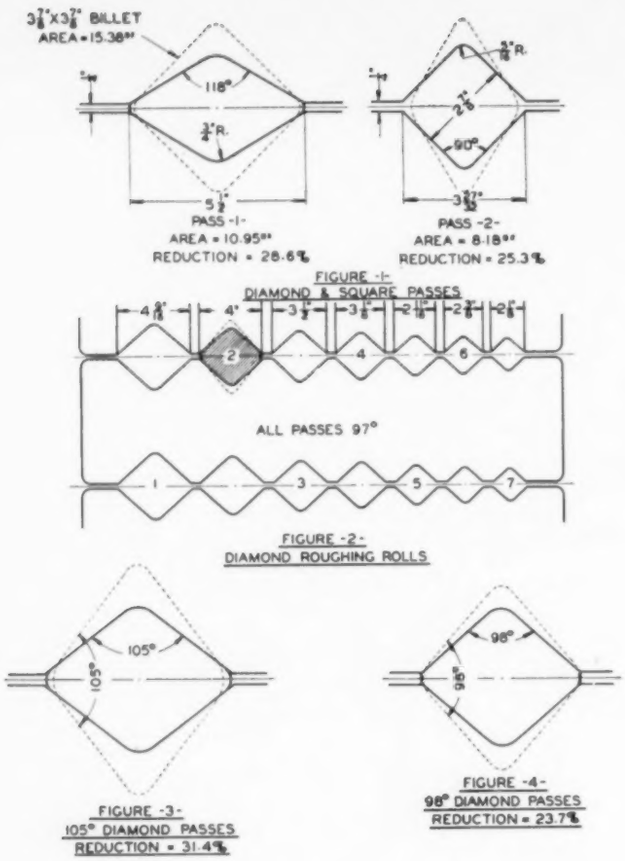
Drawing 13, shows the passes for a 1¾ in. concave round edge spring of chrome vanadium steel, rolled from a 3⅞ in. billet.

Diamond and square, and oval and square passes are used for the first six passes in order to break the billet down fast and preserve heat in the bar. After the sixth pass it is necessary to start the flat and edge formation. The 1⅜ in. square produced in the sixth pass is broken down to a 2¼ in. × ½ in. flat in one pass. This is a reduction of 35 per cent in area, and the spread is equal to the draft; ⅞ in. reduction and ⅞ in. spread. The roll diameter is 16½ in. Chrome vanadium spring steel, when given a draft such as this in a flat pass where it is free, spreads excessively.

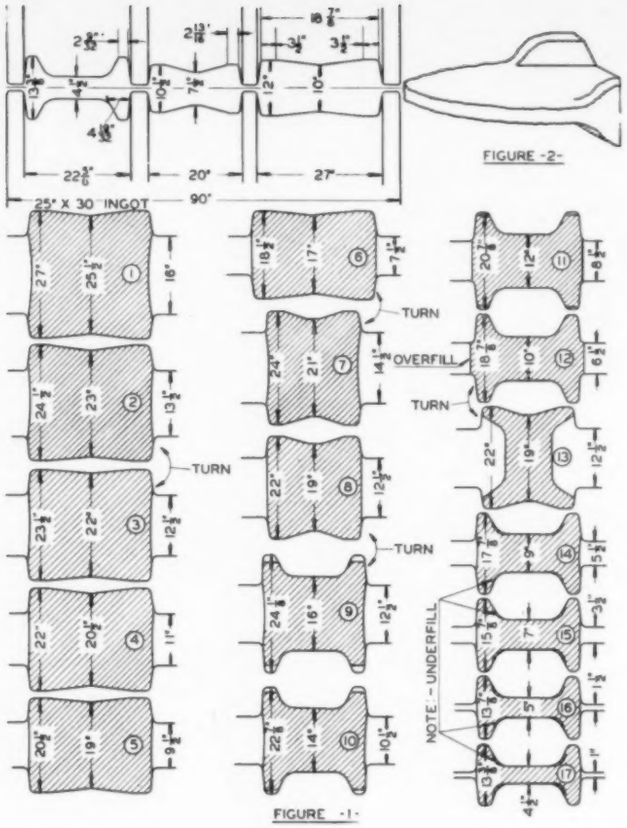
PASSES WHICH AFFECT SPREAD

Rectangular bars reduced in flat rolls are free to spread or elongate according to drafting and spreading characteristics. There are passes, however, which favor or restrict spread and elongation.

Drawing 14, Figure 1, shows some bar mill oval and



Drawing 17 — Diamond or diamond square reduction.



Drawing 18 — Shown here is the reduction of a 25 x 30 in. ingot to a 24 in. standard beam.

square passes. In the case of the square going into the oval you will note that the reduction is heaviest at the sides of the square. Ordinarily this would cause excessive spread at these points but the shape of the oval pass is such that it boxes in the square, restricting the spread, and thus more of the side part of the bar goes into elongation than the center, as you will note in Figure 2 of this drawing. The reduction in this pass is 40.8 per cent and the oval bar width is 3⅝ in. The amount of metal which has gone into spread is 0.48 square inches and this is 5.47 per cent of the area of the entering square. The average vertical reduction across the bar is $1\frac{15}{32}$ in. This same square, if given a reduction in a flat pass equal to the average vertical reduction given in the oval pass, would spread to 3¾ in. and the area going into spread would be 1.15 square inches or 13.1 per cent of the area of the entering square. This is shown in Drawing 14, Figure 3.

In pass 2 we have this same oval going into a $1\frac{15}{16}$ in. square. This type of pass also restricts spread; one reason being that the heaviest reduction is in the center, which causes extra center elongation; the other being that the 45 degree angle sides of the pass offer resistance to the spread, though not as effectively as the oval. It is the shape of these passes which allows little spread and great elongation, and makes them favorable for heavy reduction.

In the line of oval and square passes shown, the reductions are smaller in percentage as the passes decrease in size. This is partly because the bars are getting colder and spread more as they do so. As the spread becomes greater in proportion to the draft, allowance must be made for this spread in the passes in order that the bars will not overfill. In the effort to compensate for greater spread, the smaller passes are made wider and thinner proportionately. The arc of the oval radius thus becomes smaller in size as the passes become smaller. The ovals as they become flatter and wider afford less of the boxing-in effect on the squares, as previously described, and thus offer less resistance to spread.

Drawing 15, illustrates some 10 in. flat passes designed to spread excessively with correspondingly smaller elongations. Passes of this kind are used where roll diameters are small for the desired bar width or where large size billets are not available.

The shape of the passes which have the heavy reduction on the sides and lighter reduction in the middle, with their corresponding elongations, favor excessive spread of the outer parts. This is the result of the resistance of the center part to being stretched by the greater elongation of the outer parts, which in turn causes the outer parts to spread.

DIRECT AND INDIRECT DRAFT

In considering the effect of elongation and spread in the rolling action, it has been shown that there are

forms of passes which favor elongation and some which favor spread. In general the form of pass in which the rolling action is nearest to flat rolling gives the best possible results in reducing sections quickly; while the least effective are those forms which resemble the flat on edge rolling design.

It is customary to refer to flat rolling as a direct rolling action, while work on a bar in a vertical position and, particularly, when that work is done on the sides, is called indirect rolling action.

In most cases, as the work goes by degrees from the flat position to the vertical, it becomes more difficult to draft a bar properly for reduction, elongation, and spread.

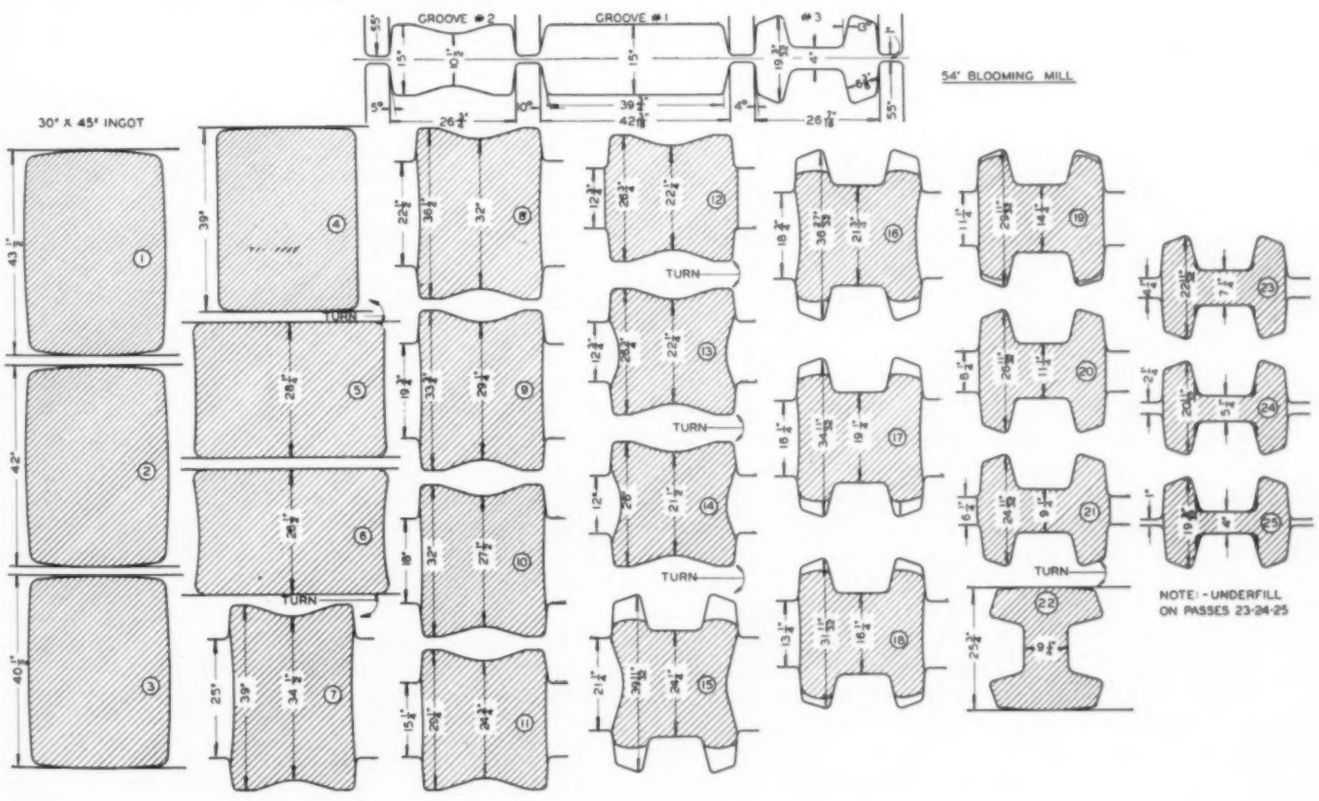
As an example and to illustrate what is meant by direct and indirect draft, refer to the sketches on Drawing 16. These sketches do not represent any known section but are chosen only to illustrate the principles, and to show a bar in which the heavy part can be expected to fill properly in each example, while the effects of drafting are considered on the flange of the piece. Figure 1 shows the flange being reduced by direct rolling action. In this figure there is no difficulty in filling the pass with the stock as shown by dotted lines. In Figure 2, with the flange at an angle of 45 degrees the flange cannot be filled with the same stock as shown in Figure 1. The flange will be underfilled in its length. This is due to the fact that the nearer to a vertical position the pass is, the more the roll pass elongates the bar, and as the rolling plane approaches the vertical position, a wedging or choking action of the rolls restricts spread and increases elongation.

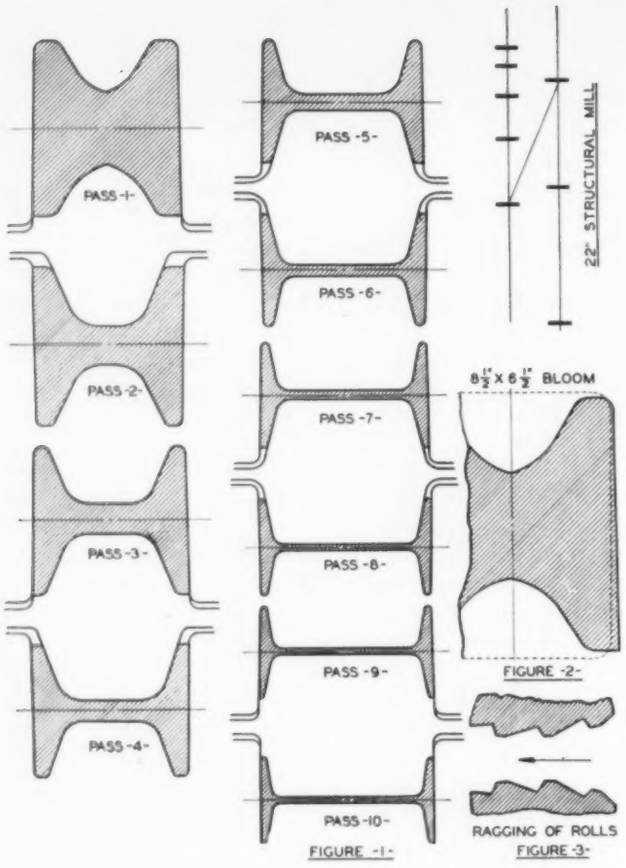
In Figure 3 of this drawing, the flange is in the upright position and, because of the taper of this section, a live pass such as shown in Figures 1 and 2 cannot be used, consequently, a dead hole, as shown, is the only one possible. In this case the same amount of reduction as used in Figures 1 or 2 would not fill the pass, but rather it would be "choked" and the flange would be badly underfilled. In this type of pass the stock would have to be much longer and thinner than that shown in Figures 1 and 2, as indicated in the sketch, and the only direct rolling action would be on the end of the flange. Figure 1, then shows direct rolling action, Figure 2 shows partly direct rolling action, and Figure 3 shows indirect rolling action.

DIAMOND AND DIAMOND AND SQUARE REDUCTION

Refer to Drawing 17, Figure 1, which illustrates some diamond and square passes. You will note in Figure 1 of this drawing, that most of the reduction is in the center of the pass, the sides having little reduction in an up and down direction. This favors elongation of the center part of the bar. Such a pass restricts spread to a marked degree. The small diameter at the deepest part of the pass also favors extrusion at this point, as we have already seen that small diameter rolls produce more extrusion and less spread than rolls of a larger diameter. Figure 2 shows a diamond roughing roll set where diamond is entered into diamond, also favoring elongation of the center of the bar. Figure 4 shows the reduction obtained in a pass of this kind. Unfortunately, the fullest advantage cannot be taken of these diamond roughing stands. Considerable reduction could be had in a design of this kind if the diamonds could be made

Drawing 19 — This drawing shows the passes designed to reduce a 30 x 45 in. ingot to a 14 in. beam blank.





Drawing 20 — The passes here will reduce an 8½ x 6½ in. bloom to an 8 in. standard beam.

rather flat, say at a 105 degree angle as in Figure 3, but they would have a tendency to turn down when entered with this degree of angularity unless held up by guides. Guides of the type mentioned are not practical with a roughing pass of this kind, as there would be too much difficulty in entering the bars.

FORMATION OF BEAMS AND CHANNELS

Previously we have discussed the drafting of a shape corresponding to a beam blank. From the discussion it might be thought that rolling a beam blank from a rectangular bloom is impractical, because of the heavy web reduction as compared to light flange reduction. However, it is possible to roll a blank in a succession of passes, even with the unequal reduction, though theoretically it seems difficult. This is because the steel at this early stage of the rolling is hot, soft, and ductile, and the rolling being done at a comparatively slow speed, allows time for the steel to adjust itself to radical changes in shape, which cannot be done so easily when it is colder.

Referring to Drawing 18, Figure 1, which illustrates the reduction of a 25 in. × 30 in. ingot in a 40 in. two-high blooming mill into a beam blank for a 24 in. standard beam, pass 8 shows a rectangular bloom with concave sides which is turned 90 degrees to enter pass 9, a 24 in. beam blank pass. In the first time through this blank pass, the groove is partly filled as shown on the drawing. At this point the question could be asked as to why the flanges are formed as shown? Why are they not drawn into length with the elongation of the center part, which is the only part to have reduction? These questions can be answered by stating that, while the center part is being elongated by reason of the draft, the outer parts not being drafted are resisting elongation. A compromise takes place between the opposing forces and, owing to this compromise, which restricts somewhat the elongation of the web, the flange portions become partly filled. However, this restricted elongation of the center part causes the blank to spread considerably. After this first pass we have a partly shaped section and passes 10, 11, and 12, having increasingly better proportions, offer a still better compromise action in elongation and the flanges gradually become filled until in the twelfth pass they are completely filled. At this fourth pass through the beam blank groove, in spite of the fluted sides produced in passes seven and eight, the sides become so badly overfilled at the roll parting that it is necessary to turn the blank 90 degrees and go back through the fluted pass to reform the flute. After the bar has been edged, it is returned to the beam blank pass for four more draftings, after which it is fully shaped and ready after cropping for further rolling.

The appearance of the ends of these blanks before cropping show the severe strain to which the various parts have been subjected by unequal elongations. See Figure 2, which shows that the center parts are elongated considerably more than the flange parts.

This pulling and stretching of large beam blanks gives rise to another phenomenon, which an inspection of passes 14, 15, 16, and 17 will show. During rolling, the web at the front and back ends of the blank is free to elongate more than the flanges, and does so. Near the middle of the blank the web is not as free to elongate and is kept from spreading extensively by the collars of the pass, except at the very roll parting. As a result, the spreading of the web near the middle of the blank prevents the flange from filling fully at the base as shown in the figure. This underfilling only occurs in the last few passes. Observation of the rolling shows the flanges filling perfectly up to the last several times through the rolls, and then becoming gradually underfilled at the base of the flanges. This occurs mostly in the middle of the blank, the ends being filled more perfectly.

Drawing 19, shows the passes for a 14 in. beam blank for a beam mill. In this design the ingot is bloomed down by the usual method until it enters the groove designated No. 2 on this drawing, which has a heavy swell in the center. After rolling to a suitable size in this pass, it is turned and re-entered, given one pass, turned and re-entered again. This rolling gives the approximate shape of a beam blank, and when entered into the beam blank pass, allows for more flange reduction and less web reduction, and room for considerable spread before overfilling the pass. This beam blank has exceptionally large flanges and a comparatively small web width, and the fairly uniform distribution of draft allows the blank to be finished in the groove with only one removal to groove No. 1 for edging off the overfills.

The same underfilling of flanges occurs in the middle part of this size blank as previously described.

SMALL BEAMS

Smaller beams rolled from a rectangular bloom in a finishing mill afford an insight into some other interesting variations of elongation and spread. Drawing 20, Figure 1, shows the passes for an 8 in. standard beam rolled in ten passes from an 8½ in. × 6½ in. bloom. In smaller sizes of beams the use of a shaped bloom is avoided, as it restricts the output of a blooming mill to produce such a small blank. In this formation it is essential to first produce a beam shape and then roll it into the finished sizes in the ten passes, which are all the producing mill affords.

In the formation of these narrower depth beams, quick initial shaping is favored by the narrow width of the passes. See Figure 2 of this drawing. Because of this, the web section of the pass can be shaped similarly to a wedge with a rather sharp edge. This wedge then cuts its way into the bloom and separates the metal into two flanges with a narrow web. Thus the web is not elongated to any great extent. The amount of flange which can be obtained in the first shape pass depends on the height of bloom, width of cutting web part, and sharpness at the point of this web part.

The diameter of the rolls and the rpm play important parts in the formation of the beam. A slow speed and large roll diameter permit heavier reductions than rapidly moving small diameter rolls. In either case the reduction necessary to fill the pass is great, and the web part must be heavily ragged in order that the rolls will have the bite necessary to pull the bloom into the rolls. Ragging, as shown in Figure 3 of Drawing 20 is commonly used to provide this bite.

The first pass having provided a beam shape, the succeeding passes further shape and reduce the beam into its finished size. In the second pass the beam must be reduced in the web, the flanges reduced in thickness, and the bottom flanges as produced in pass 1 rolled on the ends to regulate the flange length. The top flanges produced in pass 1 are reduced in thickness only as it is necessary to keep them as long as possible. They will be shortened enough by being drawn along with the web elongation, which is considerable.

As the flanges become thinner in the second and succeeding passes, the web becomes wider owing to less flange thickness and also because each succeeding pass is turned wider to allow easy entrance from the preceding pass. Thus the cutting action of the web which

Drawing 21 — Diagonal rolling gives an entirely different effect from the straight method of rolling beams.

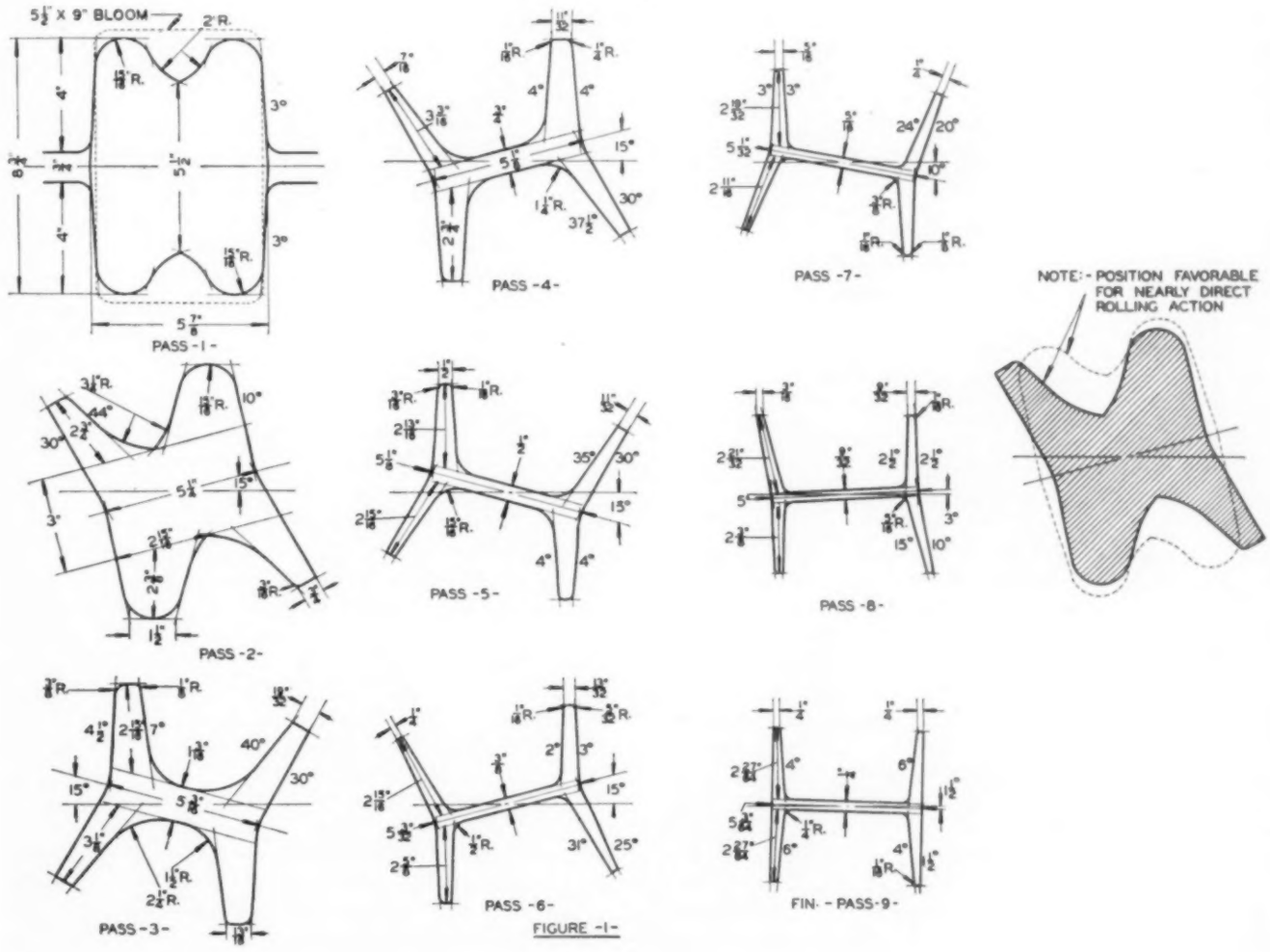
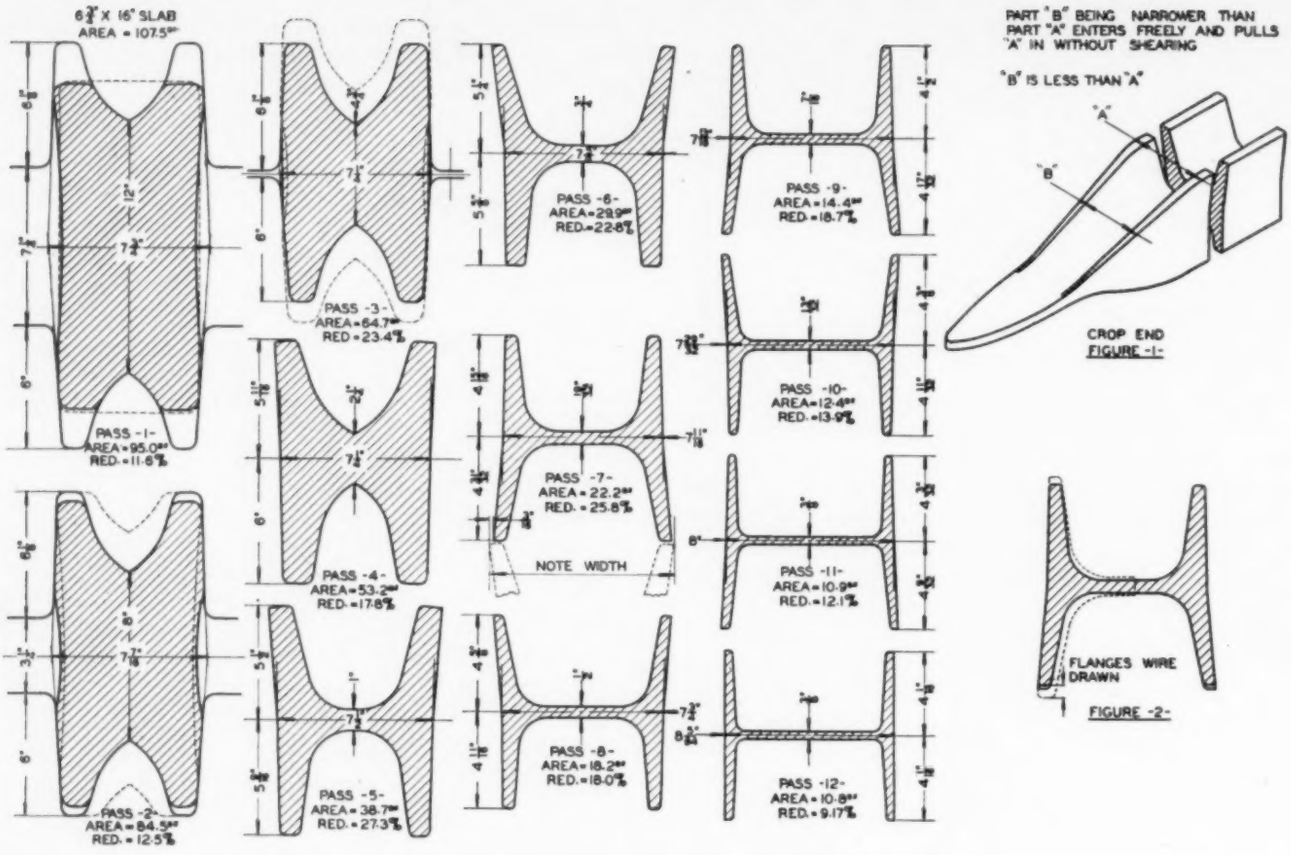


FIGURE -1-



Drawing 22 — Straight method of rolling 8 in. H-beams.

existed in pass 1 is lost and a direct rolling action takes place, and this greatly elongates the web. The elongation of the web draws the flanges along and reduces them in height. In designing the passes it is preferable to reduce the web as rapidly as possible in the early stages, trying meanwhile to keep the flange height at its maximum, in order that the web reduction and elongation in the finishing passes can be small. The flanges will then be large enough to give sufficient drafting to finish the beam with well rolled and filled flanges.

ELONGATION AND SPREAD IN THE DIAGONAL METHOD OF ROLLING BEAMS

In rolling beams by the straight method we find the flanges being wiredrawn by the web elongation and also by the inadequacy of the side flange draft. In the diagonal method of rolling beams we have an entirely different effect.

Refer to Drawing 21, Figure 1, which shows a design for a 5 in. special beam rolled on the diagonal. The first pass is beam shaped and the blank is rolled thus simply to start the shaping. A rectangular bloom entering directly into the first diagonal pass has a tendency to roll over in the pass. Shaping it slightly beforehand prevents this.

The flaring out of the live flanges permits a fairly direct rolling action and, consequently, considerable draft can be given. The dead holes being large in area in the first passes resist being stretched by elongation, and thus the live flanges are free to spread.

The diagonal method is one where a great deal of flange length can be obtained in the early passes and maintained right down to the finishing. As this type of pass is used mainly for H-beams where the flanges are long and not provided with much taper, there cannot be much side work in the dead holes. Any excess of side work will cause choking of the entering flange and the pass will not be filled.

When the dead passes are choked, the live flange is pushed up on that side, and if the roll has a stop, it will overfill at that point. The dead flange will be short and we will find a short overall flange with an overfill on one end.

The cutting effect of the first diagonal pass is very pronounced, as the roll collars offer no resistance on the live flange side and the action is a good deal like cutting a slice of bread.

ELONGATION AND SPREAD IN THE STRAIGHT METHOD OF ROLLING BEAMS

H-beams for various reasons are sometimes rolled by the so-called straight method and offer some interesting examples of loss of flange length by wiredrawing.

Drawing 22 shows the passes for an 8 in. × 8 in.

H-beam rolled in twelve passes from a $6\frac{3}{4}$ in. × 16 in. slab.

The first pass which is a beam shape, rolls the slab three times. In the first time through, the web is cut to 12 in. In the second pass it is reduced to 8 in. and in the third to $4\frac{3}{4}$ in. Owing to this reduction being edging work on a rather narrow slab, there is no overfill at the roll parting. The reason for this has already been explained in the remarks on the edging of flats. The next two passes have the live flanges flared out in the effort to have some direct rolling action. After these first five passes the web has been drawn out by the elongation to where it is ahead of the flanges. See Figure 1. In the next pass, number 6, it is possible to flare the flanges out to where they are wider than the pass they enter which is pass 7. The reason the bar from pass 6 will not shear on the roll collars, though wider than pass 7, is that the web enters the rolls before the flanges and the flanges are pulled into the pass and bent in at the same time. The taper of these passes is gradually reduced until the finishing pass straightens up the flanges to $\frac{1}{3}$ of 1 degree.

Although the flaring out of the flanges permits a certain degree of side work on the live holes, the small taper of the dead holes will allow very little side work and the web work draws the flanges down. Note in Figure 2 how the dead flange is made longer than the live flange it enters and still does not quite fill the pass.

The 5 in. beam rolled on the diagonal used a $5\frac{1}{2}$ in. × 9 in. bloom to roll the 5 in. flange. The 8 in. beam required a slab 16 in. high to fill the 8 in. flange. This is a good illustration of the stretching and wiredrawing of the flanges consequent to the web reduction and elongation in the design used on the 8 in. × 8 in. H-beam.

This web reduction and the resulting elongation must be carefully proportioned so that the flanges will not be drawn too much. An extra $\frac{1}{32}$ in. more in web reduction in a pass will often pull the flange height down $\frac{1}{8}$ in., and $\frac{1}{32}$ in. less web reduction will increase flange height appreciably.

CHANNELS

Drawing 23 shows the passes for an 8 in. standard channel rolled on the same mill as the beam previously shown on Drawing 20.

The first four passes of the 8 in. beam are used to produce this channel. It is common practice to roll beams and channels of the same depth in the same roughing passes. This is more a matter of roll economy than design. It also saves roll change time when going from beams to channels or vice versa.

Having already discussed the forming of the beam, we can start the channel description beginning at the fifth pass. As a beam shape has already been formed in the fourth beam pass, it only remains to roll the channel in the last six passes. In the first four of these six passes the bottom flange is rolled away.

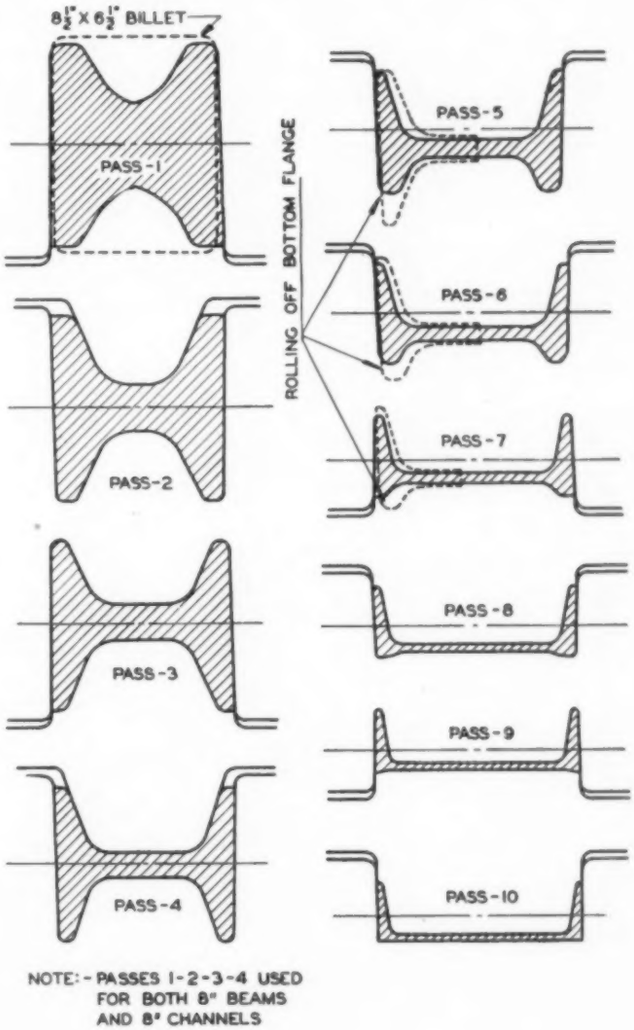
Drawing 24, Figure 1, illustrates the passes for a heavy 8 in. special channel. This channel is rolled in an entirely different manner from the standard channel just discussed. The section is bent up from a slab and, owing to the design, fairly uniform drafts on web and flange are taken, as you will note on the charts for web and flange reduction. See Figures 2 and 3. The area reduction chart as shown in Figure 4 follows a different pattern.

Roll diameter and lack of strength prevent the application of heavier drafts on passes 1 and 2. The use of a thicker slab and consequent heavier reductions in pass 1 and 2 would be practically impossible because the roll diameter is not large enough to pull the bar into the pass.

In channels such as these, which have very little taper on the inside of the flanges, an underfilled condition often occurs which can best be explained by referring to Figure 5 in Drawing 24. This shows a leader pass that is popularly used on channels of this kind and the reduction (shown by dotted lines) which is taken in it. The figure also shows the finishing pass to correspond with this leader pass.

Earlier in the paper it was said that edging passes were of very little use in reduction, and that in edging passes the tendency was for the top and bottom edges of a flat being edged in plain rolls to be upset and thickened on the top and bottom and that the inner parts would be unaffected or wiredrawn.

Drawing 23 — Shown here are the passes to roll an 8 in. standard channel on the same mill as the 8 in. standard beam.



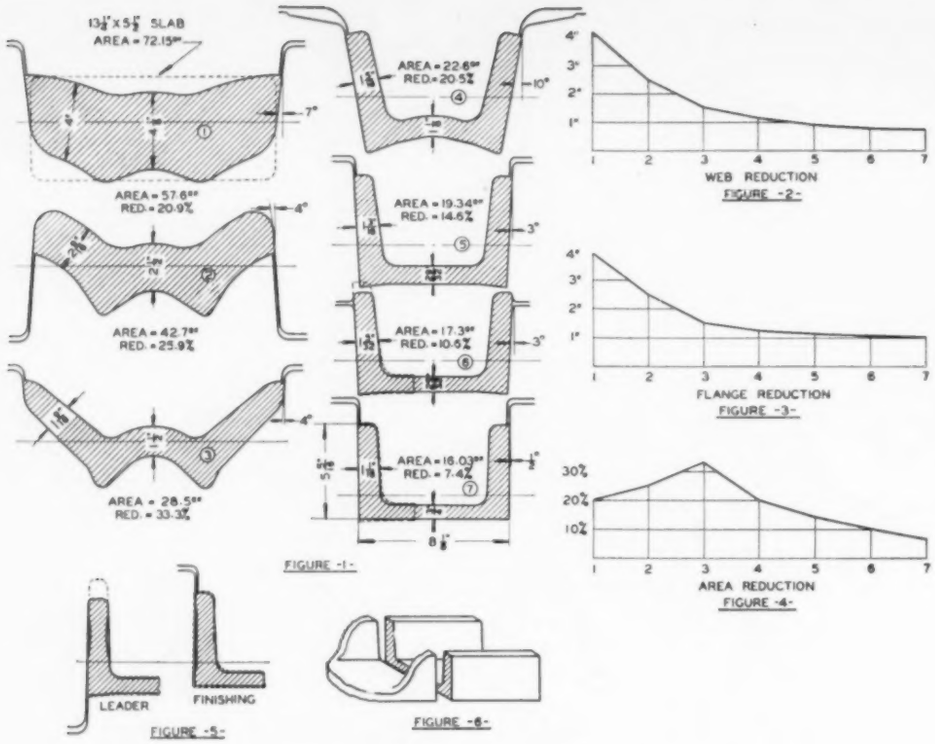


FIGURE -1-

FIGURE -2-

FIGURE -3-

FIGURE -4-

FIGURE -5-

FIGURE -6-

Drawing 24 — The 8 in. special channel shown here was drafted in a different manner than the standard channel shown in Drawing 23.

The drafting in the edging pass shown in Figure 5 offers a perfect example of the effects of such drafting. A leader pass such as this one has very little taper on the flanges. As it is relatively straight there can be no rolling action from the sides. The only reduction can be on the ends and in the fillet at the bottom. Besides this it is usual to make the flange from the previous pass slightly thinner to prevent it from becoming wedged in the pass, causing the flange to tear loose from the web and wrap around the roll. Under such conditions the pass becomes filled as shown by the hatched lines, that is, thicker at the top and bottom than in the center.

This flange, then, is entered as shown into the live finishing pass which also has little flange taper. The small flange taper precludes having any great amount of flange work.

Thus we have an entering flange which has some flange side work on top and bottom but no side work in the center. The top and bottom reductions will fill the finishing flange, but the center part will not be filled and the finished flange will be as indicated by the hatched lines. This condition almost always exists on the outside of the flange, rarely on the inside.

Again refer to Figure 1 in Drawing 24, which shows the leader, pass 6, used for rolling this channel. It is designed differently from the one shown in Figure 5. You will note that the flange is a live groove tapered 3 degrees on the outside, the only closed part being within ½ in. of the top of the flange. We have already learned that a pass is more effective for reduction the nearer it approaches the horizontal plane. Owing to the taper of the pass, it is possible to have a small degree of side work with no possibility of choking, and this work is so arranged that there is some reduction on the sides at all points except at the opening near the top of the flange. The flange from the previous pass upsets at the top in the usual manner and fills the flange at this point, and side work at all other points, except at the roll opening, fills the pass perfectly. This leader then gives the right amount of side work all over on the

Drawing 25 — The universal beam mill features direct rolling on both flanges and webs.

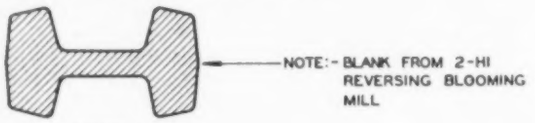
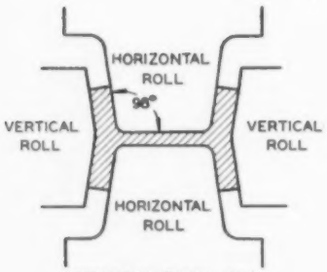
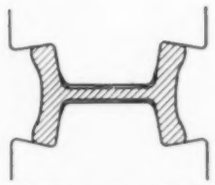


FIGURE -1-



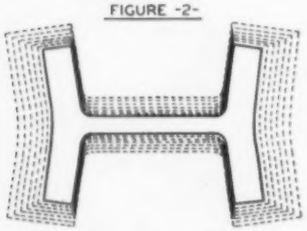
UNIVERSAL BEAM MILL ROLL STAND

FIGURE -2-



EDGING ROLL STAND

FIGURE -4-



PASSES IN UNIVERSAL MILL

FIGURE -3-

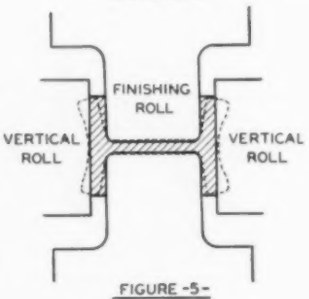


FIGURE -5-

finishing flange so that it is flat on the sides. Figure 6 of Drawing 24 shows how the almost perfect elongation of web and flange result in a very small crop.

CHANNEL BEAM SECTIONS

Most standard beam and channel sections are produced by a combination of "live" and "dead" grooves in which the web of the beam is rolled by what has been called direct rolling action, in which the web is rolled in a horizontal or nearly horizontal plane, and the flanges by indirect rolling in a vertical or nearly vertical plane. In this kind of rolling the flanges are partly rolled and partly drawn, and a 10 in. flange is about the limit that can be produced on a standard structural mill in this country.

The universal beam mills have no limitations of this kind and are able to produce flanges up to 16 in. The universal beam mill also features direct rolling on both flange and web, and as there are no "dead" holes in the mill, all of the flanges are "live."

Drawing 25 shows some universal beam mill roll combinations which illustrate how parallel flange beams are rolled on this type of mill. The beam blank for the universal beam mill is produced on a two-high reversing blooming mill in the usual rolling practice for beams. See Figure 1. In the finishing mill, however, the practice is entirely different from that of the standard structural mill. Figure 2 shows the universal mill with four rolls operating on the piece at one time, two horizontal rolls and two vertical rolls. In the design shown, the flanges are at a 98 degree angle with the web. With this arrangement there is very little friction on the sides of the main rolls; much less than there would be if the sides of the main roll were 90 degrees with the roll axis. This arrangement also permits the rolling of parallel flanges. Screws operate each roll of the four so that any combination of drafts can be had. The rolls are reversing and the bars are rolled forth and back in this roll stand with no idle passes.

The beams produced on a mill of this kind usually have a thicker flange than web. This means that in order to have proportionate elongations in web and flange, each preceding pass from the finishing back to the beam blank must be increased in proportion. In this type of mill there is no difficulty in doing this. Refer to Figure 3 of this drawing, which shows the passes over each other.

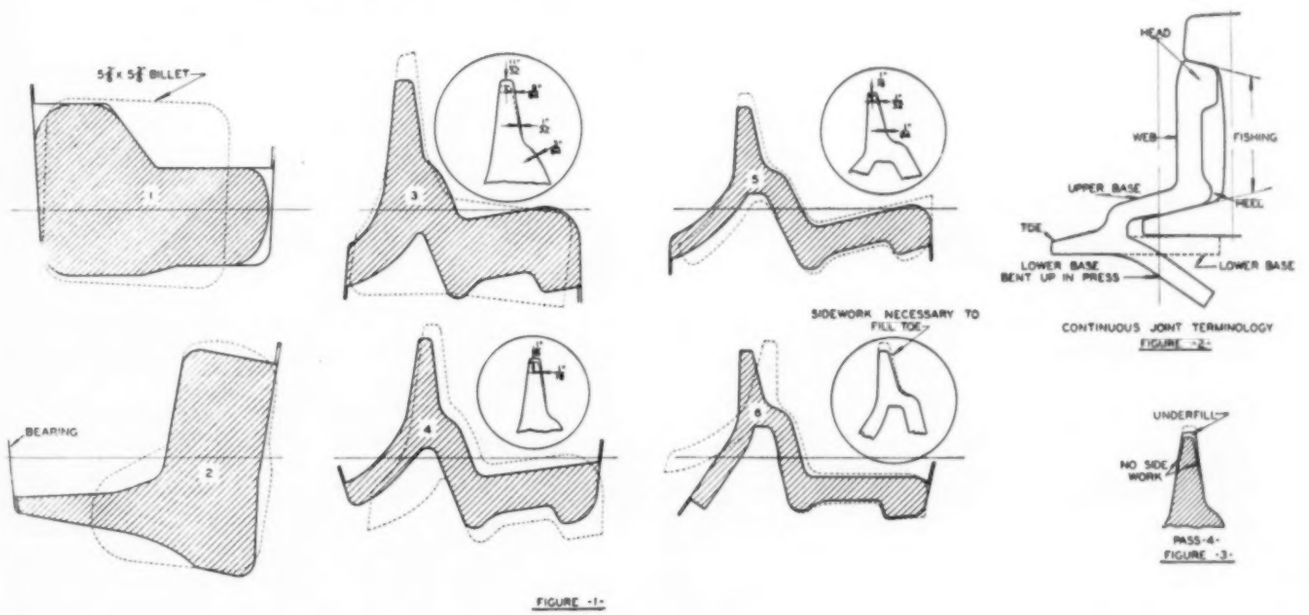
In a roll standard of this kind there is no means of regulating the length of the flanges, which spread more or less according to temperature and draft. The flange length regulation is accomplished by the two roll stand shown in Figure 4 of Drawing 25. These rolls operate on the ends of the flanges only, and in the first few passes where the flange is thick, there is some reduction in flange length. When the flanges become thin, these rolls merely hold the flange to the overall size, and in these later passes there is no area reduction on the bar. The edging rolls upset the flange ends, an effect similar to the edging passes of flats.

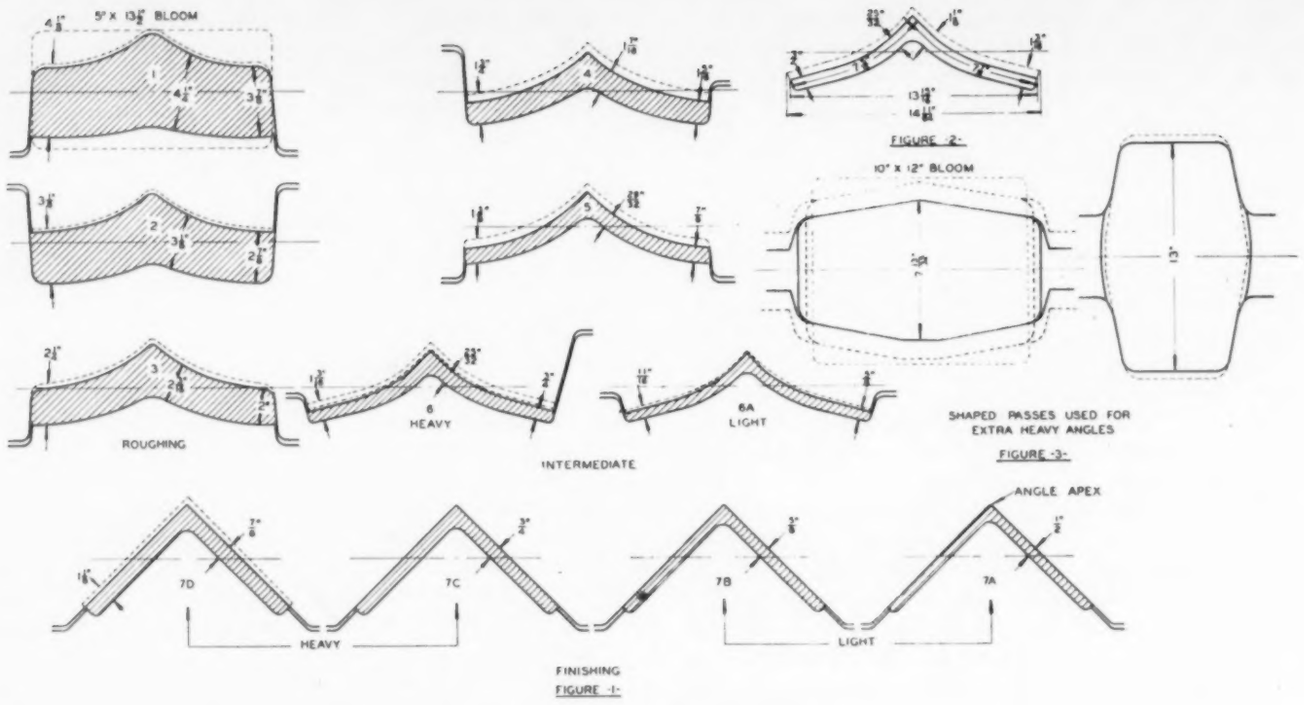
After the beam is rolled on this universal set with the flanges at an angle it becomes necessary to straighten up the flanges so that they are 90 degrees with the web. This is done in the finishing set shown in Figure 5 of the same drawing. This set has a very small degree of taper on the horizontal set so that the flange will not grind on the rolls, but for all practical purposes, the flanges are parallel.

CONTINUOUS RAIL JOINTS

As discussed in the rolling of beams and channels, wiredrawing of flanges is caused by elongation of other parts of the beam or channel. A good example of this wiredrawing is in the rolling of a continuous rail joint.

Drawing 26 — Rolling of a continuous rail joint is shown in this drawing.





Drawing 27 — Rolling of an 8 x 8 in. angle section.

See Drawing 26, Figure 1, for the passes used. Figure 2 of the drawing gives the names used to designate the different parts of this bar. The toe, as designated in this figure, is produced in dead grooves in the last four passes of the design and it is in this part the wire-drawing occurs. One of the rules handed down from the old roll designers was that no side work could be used in a dead hole. This is not true in many cases. Refer to Drawing 26, Figure 3. With no side work on the toe, the bar leaving this groove would be underfilled as shown in the figure owing to the stretching of this part by the elongation of other parts of the bar. Passes for these sections have been designed in this manner in the past and in each case the toe has been underfilled. In the design shown, after the first rolling has been made and the toe found underfilled, it was necessary to add to each toe pass sufficient side work to overcome this stretching and underfilling. The amounts added are shown in the toe sketches encircled. This condition occurs even when there is a fair amount of end work on the pass. The explanation of the toe filling properly, even when the thickness of the entering part might be thought to cause "choking" and consequent underfilling, is that the stretching the toe receives thins it so that it enters properly.

ANGLES

Angles present fewer problems in the control of elongation and spread than beams and channels, however, there are some points in the control of spread to be observed.

In the design shown on Drawing 27, Figure 1, seven passes are employed in the rolling of the 8 in. × 8 in angle from a slab. The design shown is known as the "butterfly" method in which the slab is gradually rolled and bent to the finished 90 degree angle. As the finished angle has legs of uniform thickness, there is no particular problem, except at the apex of the angle. At this point, due to the joining of the two legs and the radius at the joint, there is a great thickness here. Consequently, more reduction should be provided here than on the legs. The stock being a slab does not provide this, but because of the passes being made thicker near the apex than on the ends, metal is forced to flow into the apex because the greater thickness of the metal at the apex gives greater reduction and results in greater elongation at that point. The small amount of elongation at the ends of the legs and the resistance to being stretched, forces the metal to go toward the apex because the center of the bar is not able to elongate freely.

The passes, with the exception of the finishing, being tongue and groove restrict spread. The seven passes shown, marked 1, 2, 3, 4, 5, 6a, 7a, and 7b are for the lighter sections of the angle. Passes 1, 2, 3, 4, 5, 6, 7c, and 7d show the passes for the intermediate and heavy weights of the angle. It is in the heavier gages of angles that the more difficult problems occur. In the design shown the earlier passes are for all gages of the angle, separate finishing and leader passes being used for the heavier gages. Passes 1 and 2 must be raised for the heavier gages, but do not increase leg length appreciably, as they are relatively flat in shape. As the passes more nearly approach the shape of the finished section, raising the passes to increase thickness increases the leg length. Extra intermediate and finishing passes must then be provided for the heavier sizes to get correct leg

length. At this point refer to Figure 2 of Drawing 27, which illustrates the leg condition caused by raising passes to obtain a greater thickness.

Most roll lengths are not long enough to accommodate passes for all the angle gages, therefore, it is necessary to roll the heaviest gages of all in the heaviest pass available. The heaviest gages of angles as a general rule are less in demand by the customer than the lighter ones, hence, it is not economical to provide extra rolls for these heavier sizes.

Referring again to Figure 2 of this drawing, you will note that raising the passes to the extent required not only lengthens the legs but also thickens them proportionately more on the ends of the legs than near the apex. This is because the ends are in a nearly flat plane as compared to the higher angle of the upper part of the legs. The longer length of the legs is undesirable, and the increased thickness at the ends when reduced in the finishing pass causes extra spread, which still further increases the leg length. On the heaviest gages the apex now becomes more difficult to fill, owing to the use of the same slab size for all gages. As a result, the increased elongation and spread of the outer leg parts cause the metal to be stretched in the apex. In some cases the apex is so rounded that it is unsatisfactory. A form of pass used to correct this condition is shown in Figure 3 of Drawing 27. This pass is in the two-high reversing roll stand used to provide the stock for the angles shown. Passing a slab twice through this pass and then edging for width, as shown on the drawing, provides material for a sharp apex angle.

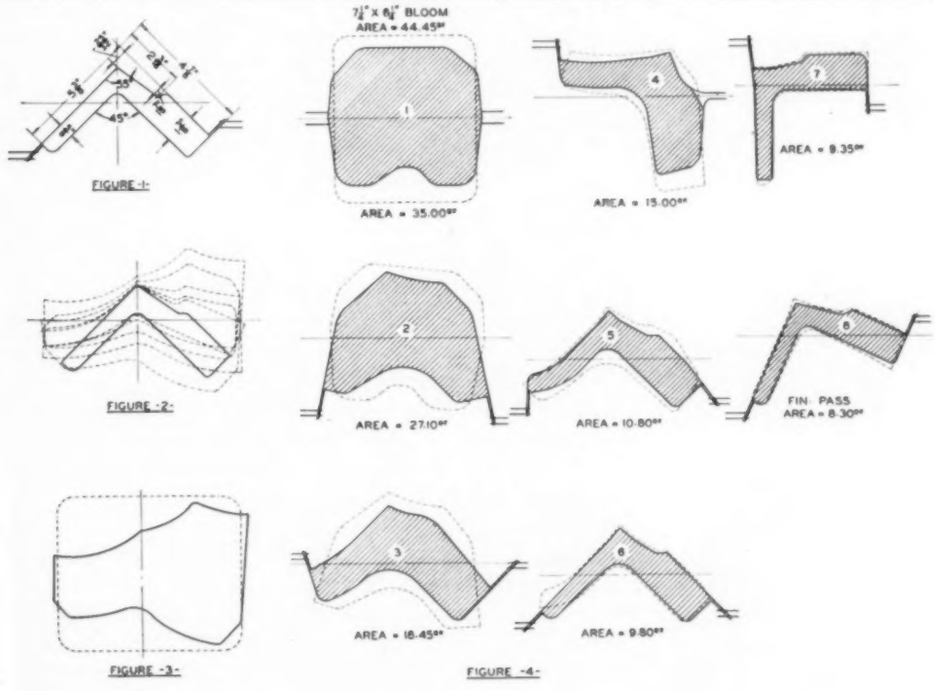
An example of control of elongation is shown in the passes of a special type angle used as a circular pinion rack. This angle had to be rolled to close tolerances, because of the use to which it was to be put. The heavy leg of the angle is more than twice the thickness of the thinner leg. See Figure 1, Drawing 28.

Making the angle in the conventional fashion would be difficult if not impossible, as will be seen by looking at Figure 2, which shows the conventional "butterfly" design as applied to this angle. Note the extreme leg thickness ratio of pass 1 in Figure 3 of this drawing. The bloom is shown in dotted lines over the first pass and has a tremendous draft on the thin leg side, while an inadequate draft is taken on the thick leg side. It can readily be seen that a design of this type would not be successful.

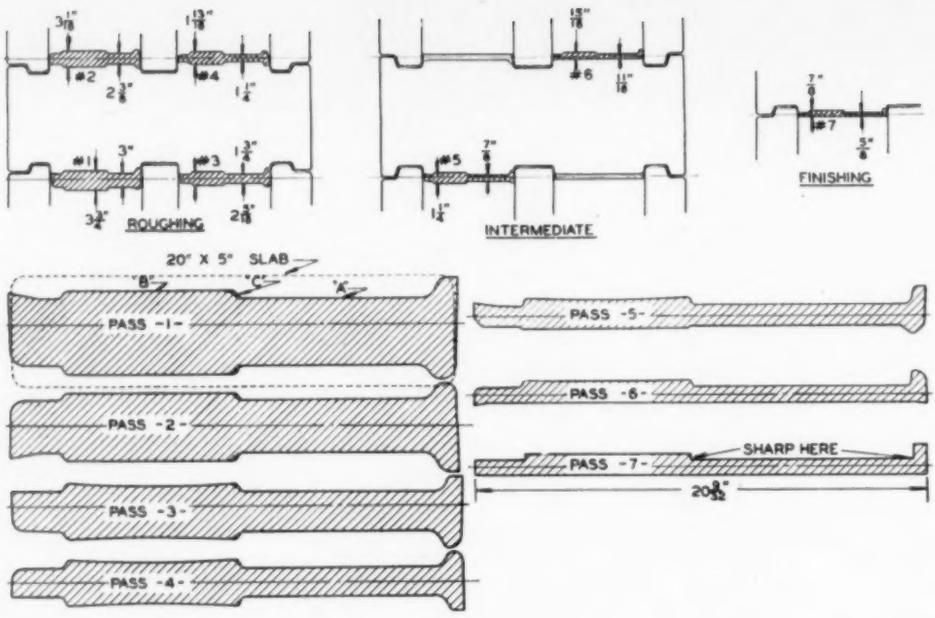
Figure 4 of Drawing 28 shows the passes used to produce this angle. The idea in back of this design is to avoid heavy reductions on the light leg, in order that the proportionate reductions necessary on both legs will not cause the heavy leg to become too large in the roughing passes. The finishing pass is put in the rolls at the angle shown to give a delivery free from a twisting action.

The leader pass, number 7 is so designed as to square both legs of the angle, the light leg being edged and the only draft it receives is the amount edged off. This light draft permits a proportionately light draft on the heavy leg, which at the same time is squared up by a tongue and groove arrangement of the pass. Pass 6 is also drafted lightly on the thin leg and proportionately more on the heavy leg for the same reasons given before. Pass 5 is drafted in slightly greater amounts than pass 6 and has the light leg curved to get the roll opening opposite to that of pass 6. Pass 4 has the thin leg curved to present an opposite roll opening and the heavy leg has been turned so that it is an edging pass. The reason for this maneuver is that the proportionate reductions required for the heavy leg will not increase it in thickness, the reduction being taken on the edge of the leg. Pass 3 is put in as shown with the light leg bent, the opening being in the same direction as pass 4, but at such an angle that the two roll openings, though on the same side of the legs, will not cause overfills or laps. Pass 2 and pass 1 can now be shaped as shown so that a rectangular bloom may be used.

The "butterfly" design shown in Figure 2 of this drawing, had it been practical, would have required an 8 in. × 6½ in. bloom. The bloom used to roll this



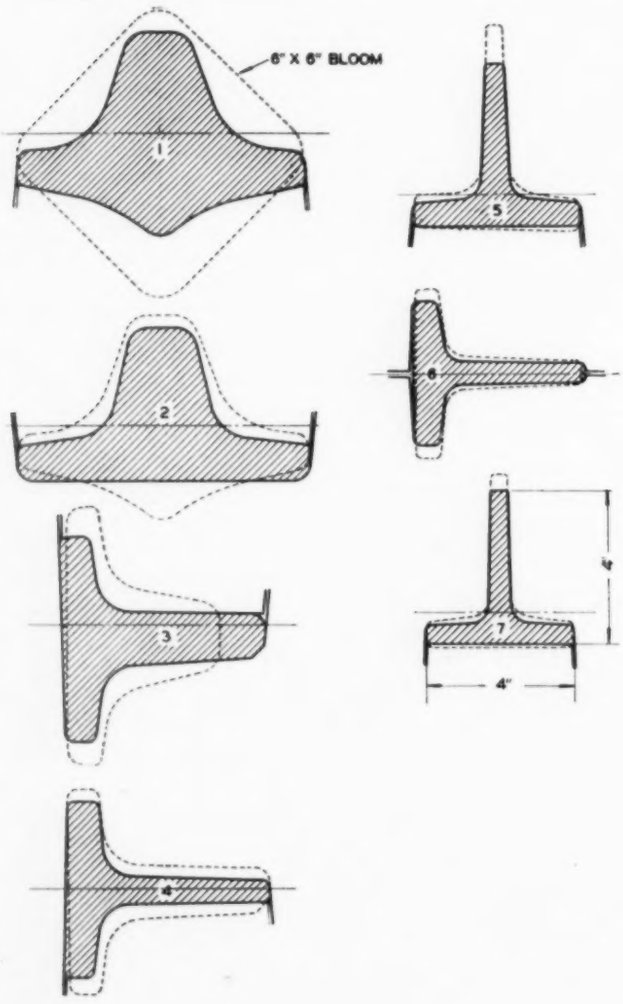
Drawing 28 — The special type angle shown here had to be rolled to close tolerances.



Drawing 29 — The rolling of this switch plate section presented a number of problems.

section was 7¼ in. × 6¼ in. and it was formed into a section close enough in tolerance so that rack teeth could be machined in and the bar used as a rack.

Drawing 30 — Seven passes are used to roll this T-section from a 6 x 6 in. bloom.



SWITCH PLATE SECTION

The section shown on Drawing 29, is a good illustration of uneven drafts and their effects on elongations as previously described.

This section is a switch plate which must be rolled to close plus and minus tolerances and with sharp corners where shown. The section was produced in 7 passes from a 20 in. × 5 in. slab. Being rolled from a slab, proportionate drafts in all parts of the bar in the first passes are not possible, so proportionate reductions can be had only in the last passes. To make the problem more difficult, the section width of 20 in. makes it necessary to work two of the first four passes over each other on account of lack of roll space.

The slab entering the first pass pulls violently to the left because of the greater draft on part "a" as compared to part "b." The greater draft on part "a" causes this part to elongate more than part "b" and, as previously explained, the bar would curve to the left if free to do so. It is not practical to handle a bar bent in this manner on mill tables, therefore, the delivery guides on the left hand side are kept very close to the bar and force it to come out of the rolls in a fairly straight line. The bar is twisted because of the elongation, though not twisted enough to cause any trouble. The "b" side of the bar is stretched out by the elongation of the "a" side. The second and third passes act in the same manner, though in lesser degree as the draft becomes more proportional between the thick and thin parts of the bar during progressive rolling in later passes.

The pulling and stretching of these first passes also causes the bar to shift to the left in the passes, and results in part "c" being underfilled in these passes. As this part in the finished bar must be filled accurately, the earlier passes are made wider at this point, so that when the bar arrives at the point where it is evenly drafted, this part will be fully filled. The sketches show how the passes are underfilled at points "c" in the early passes, but do fill when the drafting is proportioned correctly and the elongations are correct in all parts of the bar. Needless to say, a section of this kind must be

held in proper position in the rolls by close fitting guides. In the last three passes, any sideway shifting of the bar in the passes will cause shearing at the sharp corners of the bars and laps at these points. Even though the guides in the roughing passes are tight they cannot prevent the bar from shifting sideways in the passes, causing the underfilling at points "c" previously referred to.

ROLLING OF A TEE

In Figure 2, Drawing 3, and Figure 1 of Drawing 4, we have shown sections which correspond roughly to tees. In the formation of tees the elongation and spreading characteristics of these figures are used in nearly every pass.

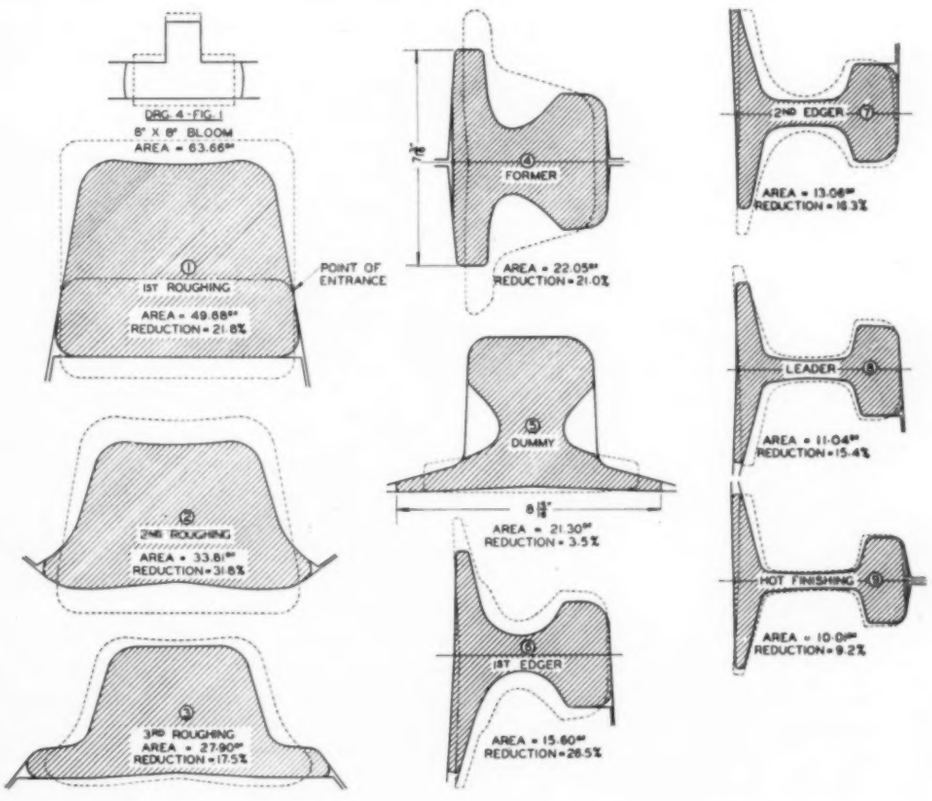
Drawing 30 shows a tee pass design. Viewing pass 1 and studying methods of filling such a pass quickly, a square or diamond entered on edge seems best, and is in fact used in many modern designs.

The square entering pass 1 will cause little spread, as most of the reduction takes place in the center of the pass. Pass 2 is another one where most of the draft is in the center, and there is little spread here also. Pass 3, however, as illustrated has considerable spread and little elongation owing to comparatively light reduction in the upright part and heavy reduction in the horizontal part. The upright part resisting being stretched, causes heavy spread in the horizontal part. The succeeding passes are reduced as shown but with lighter drafts. Passes 5 and 7 present a little problem in the control of elongation and spread. The upright leg of these two passes is rolled in a closed hole and can have practically no side work as the entering bar would wedge itself in the pass if this were attempted. The only chance for reduction is on end work in this part of the pass. As previously explained in discussing edging passes, little reduction in area takes place in edging, consequently, little elongation. In the horizontal part of these two passes, direct draft is taken, and even with the lightest possible amount of work consistent with reducing and filling the part properly, there is considerable elongation in this part. This causes a wiredrawing and shortening of the upright part as it is stretched out to equal the elongated length of the lower parts. The section provided to fill these upper parts in passes 5 and 7 must be just thick enough so they will not wedge and long enough to allow for the drawing down in length they will get because of the stretching received.

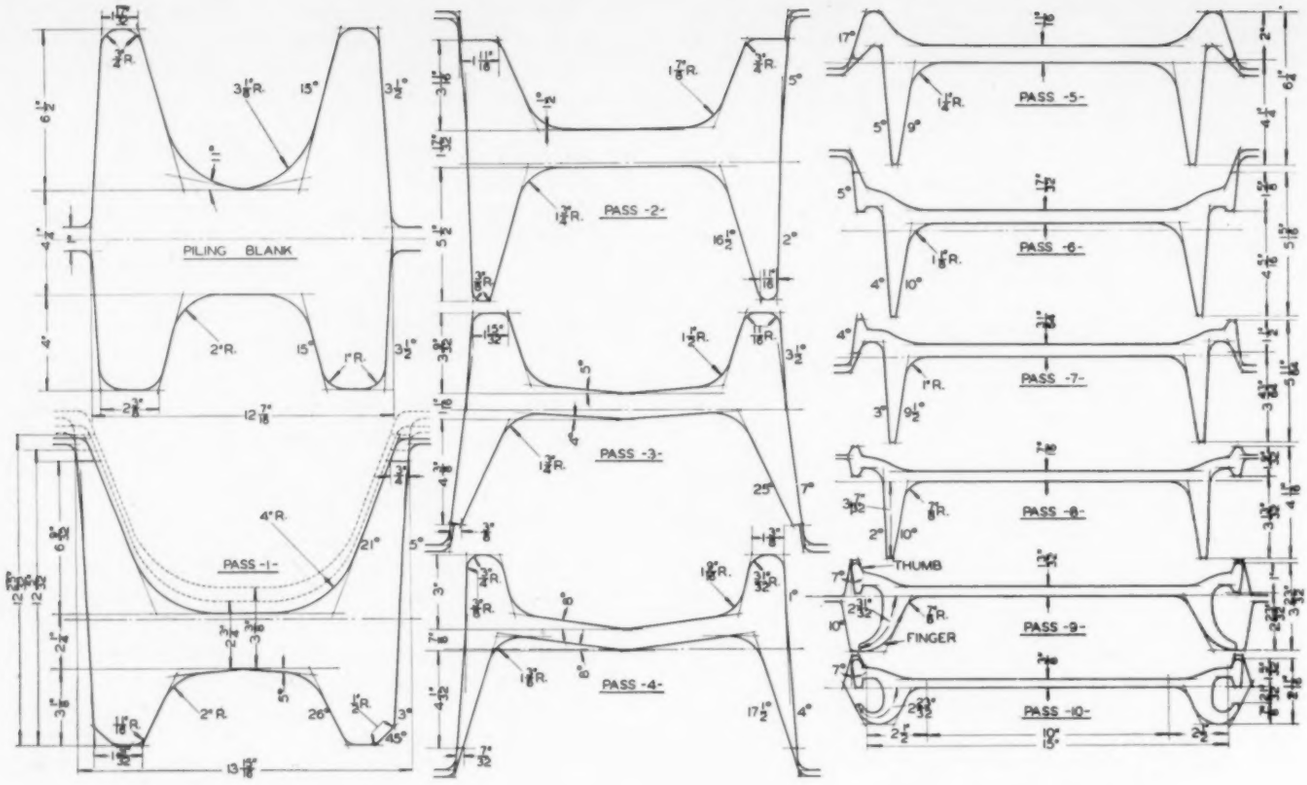
RAILS

In the rolling of rails we find some good examples of the control of pass elongation and spread by which grooves are filled to the extent desired. This is done by causing certain parts of the rail to spread extensively by restricting elongation of other parts.

Drawing 31 shows a series of nine passes for a 100 pound rail rolled from an 8 in. × 8 in. bloom. Pass 1 is used chiefly in squeezing the sides of the 8 in. × 8 in. bloom into the pass, leaving it in the form shown. It is then entered into pass 2, which squeezes the top part in while the wings of the pass mash some of the metal down from the sides and force it to spread. Pass 3 is now ready to operate on the bar from pass 2 and is a type of pass which will spread the metal extensively.



Drawing 31 — These sketches show the passes used in rolling 100 lb rail from 8 x 8 in. blooms.



Drawing 32 — The rolling of a piling bar section illustrates many of the principles of roll pass design.

The blank is then turned 90 degrees and entered into the fourth pass which has the first rail shape. In pass 4 the web of the rail is cut and rolled in. There is considerable up and down work at this point on the web, but provision is made from the considerable spread obtained, which reduces the area reduction of the pass thus lessening elongation, and permits the flanges, or rail base, to be filled rather than wiredrawn by the web elongation.

The next pass, number 5, is known as the dummy or swabbing pass. This pass is designed deliberately to have very little elongation in order that the reduction on the rail base will cause it to spread. Its function is to regulate the rail height, thin and spread the rail base. The next three passes, usually known as the first and second edgers, and leader pass, further work head, web, and base, and the finishing pass then completes the shaping. The live part of the base groove in the first and second edger and leader is bent out at an angle from the dead holes so that more direct rolling action can be had here. This feature also permits the passes to be dressed to their original size with a lighter roll reduction than if they were the same taper as the dead holes.

SHEET PILING

A sheet piling section as shown on Drawing 32 has a number of features that illustrate points in the elongation and spread principles which we are discussing. Passes 9 and 10 in a design of this kind are what is known as bending passes. You will note that the parts marked "finger" and "thumb" are not being reduced by any rolling action, although they are reduced in area by the stretching they receive by being drawn along with the elongation of the web, which is the only part being drafted in these two passes. These two passes are the source of the trouble occasionally experienced in the rolling of piling sections.

Any variation in drafting across the web of the bar such as caused by an off parallel setting of the web would give uneven drafts and uneven elongations. This would cause sideway shifting of the bars in the rolls. For instance, if bars from pass 8 in entering pass 9 or from 9 to 10 shift sideways in the rolls, the finger on one side becomes longer and on the opposite side shorter. On the longer finger side the slot would be smaller and on the short side larger.

In passes 5, 6, 7, and 8, the finger is rolled in dead holes, the only possible design because of the thumb projection at the side. We have learned that there can be very little side work in dead holes and that the only direct draft that can be applied in grooves of this type is on the end of the flanges. You can, therefore, see that the fewer dead holes used the better, and in this case four is the minimum number that can be used.

The passes from the blooming mill blank down to pass 4 are passes which present no rolling difficulties other than keeping the flanges which form the finger and thumb fairly even in elongation with the web.

Passes 9 and 10 afford examples of another phenomena. The finger of the bar being bent in pass 9 is also

edged, and this edging causes a thickening and shortening of this member. At the same time the finger becomes smaller in area, being stretched by the elongation of the web. It is customary to spray oil in the grooves of passes 9 and 10, making them slippery, in order that the finger will bend more easily and not be shortened more than provided for in the design. Should the finger be shortened excessively, the lock opening will be greater than the allowed tolerance. Generally speaking, between the edging and elongation by stretching which the finger receives in passes 9 and 10, it is shortened ½ in. divided equally with ¼ in. in pass 9 and ¼ in. in pass 10, as illustrated on the drawing.

Another deviation from the ordinary occurs in the rolling of a piling section such as this, which at first seems to be a contradiction of the theory we have been expounding. A slightly increased web reduction in passes 9 and 10 causes the lock opening to become smaller. At first thought it would seem that the increased draft would cause the finger to become shorter by stretching and the lock as a consequence, more open, but this is not the case.

The increased web draft gives greater web elongation, but the resistance against elongation of the finger and thumb parts of the bar makes for more spread in the web, and in spreading the finger is pushed harder against the roll collar, thus bending it still more and the lock becomes smaller.

In this paper the basic principle of rolling has been touched upon in a brief manner. Much more could be written and many more drawings could be used for illustration on the control of elongation and spread which must be applied in all roll designs.

This principle which we have discussed in this paper is only one of the many principles the roll designer must understand and employ in his work.

DISCUSSION

PRESENTED BY

CHARLES P. HAMMOND, Superintendent, Mill and Billet Department, Atlas Steels, Ltd., Welland, Ontario, Canada

ROSS E. BEYNON, Superintendent, Roll Shop Department, Carnegie-Illinois Steel Corporation, South Works, Chicago, Illinois

C. W. BARRETT, Roll Engineer, Republic Steel Corporation, Cleveland, Ohio

Charles P. Hammond: Mr. Beynon referred to the method of diamond and square, and oval and square, and I believe there is controversy in some mills as to the best entering pass procedure from the furnace, whether to flat and edge, diamond and square, or oval and square. Of course, this can lead to further discussion in regard to different grades to be handled. Also there are probably a number of folks in the room who are not too familiar with the term used for live pass. Would Mr. Beynon explain the difference between live and dead passes?

Ross Beynon: In answer to Mr. Hammond's question in regard to which is the best type of pass to take the billet from the furnace, whether flat and edge, diamond and square, or oval and square — flat and edge passes are used mostly for descaling work. Putting the billets in on edge in the first pass allows the scale on the free sides to drop off, and when turned 90 degrees for the second pass the scale drops off on the sides which are free in this pass.

The oval and square design is not used in large sizes, (though it is effective in small sizes) because scale is rolled in, and it also is difficult to fill a large oval and the sides which are not filled become rough with scale and this rough side is rolled into the corner of the succeeding square pass sometimes causing small seams to develop.

The diamond and square method is one of the popular methods in medium sizes, though it rolls in more scale than the flat and edge design, in alloy steels particularly.

On the other question as to what are live and dead flanges; if I had a piece of chalk I could explain it by a drawing. In the case of a beam pass, for instance, the bottom roll has the lower flange completely enclosed and this flange then is called a dead hole because of the fact that little reduction is taken in it. The upper flange is divided between the bottom roll and the top roll and considerable reduction takes place here; therefore, it is called the live hole.

C. W. Barrett: We all hear a lot of questions and answers relating to surface quality and so forth, principally in the finished product, but we all pretty well agree that some of it originates back in the ingot forms, and there are some reasons to think that speed of reductions and the amount of reduction and the size of the mill have something in common in causing us to have improper surfaces and in the trapping of non-oxidizing gases in the ingot forms. I wonder if you would like to comment on that?

Ross Beynon: Some experiments are taking place at the present time to determine what effect blow holes have on surface conditions, particularly on slabs. A series of experiments have been made of these blow holes from the beginning, taking the ingot right down to the slabs and some blow holes can be detected, in a number of cases, in the finished slab.

The manner of working the ingot to produce a slab has a great effect in putting these blow holes away from the surface and in a position where they are not likely to cause a slab much damage. For instance, working an ingot all in one direction only has a detrimental effect on edges particularly.

It has been discovered that light reductions in the earlier passes and more turning reduces the troubles that you are speaking of in surface condition, particularly on slabs. The experiments which I spoke of earlier are not sufficiently advanced for further discussion at this time.

Job Evaluation

By L. H. BROWN, Chief Industrial Engineer
Wheeling Steel Corporation
Wheeling, West Virginia

. . . . job evaluation is a step in the direction of rewarding men equitably according to their efforts, responsibilities, and capabilities . . . . a step, however, which is not an exact science, but dependent largely on sound judgment . . . .

▲ WHILE job evaluation today is among the most important subjects in labor relations, it is a comparatively new subject to most businessmen, and it is very difficult to find a plausible reason why it should be new. The overall picture is that it deals with people's security, and, on the whole, there is very little factual information in connection with it.

Items that contribute to this are, no doubt, the fact that mass production as we know it today, and changes that have come about in recent years, have had decided effects on the subject as a whole. For instance, prior to the first World War, there had been very little done in connection with job evaluation. When we came into the first World War, we had a substantial increase in rates of pay, and it was more or less known throughout the country as the "silk shirt" period.

When the war was over, we maintained those rates, or standards of living, through technological changes in industry and various other items as a whole that left us in a position to maintain the rates of pay in established businesses, while in new businesses the rates were substantially lower to start with, and they remained that way until we came to the so-called depression.

During the depression period, we had a situation where job evaluation at that time resolved itself virtually into how little we had to pay to get a job done. we continued through that period to the point where we came into wage agreements with our unions. We had the National Industrial Recovery Act to put a floor under wages, and up until that time, that was probably the first evidence of job evaluation that we had.

The second World War then brought on a new spiral of wage increases, and in connection with those, we had various governmental orders for the stabilization of wages. We were not permitted to reduce certain wages, nor were we permitted to increase wages without specific approval.

From the beginning of individual enterprise, businesses have always evaluated jobs, sometimes correctly and sometimes incorrectly, but it may be said without a question that in the main these arrangements, or deals, that were made in connection with wages were without foundation, had very little rhyme or reason to them, and, as a whole, the entire field was very poorly covered, and the reason for which no one seems to be able to tell today.

There are very, very few businesses today that have well-established job evaluation plans. Where accurate plans were not developed, employees were usually paid on the basis of supply, demand, necessity of talent, and in order to meet competition. In other words, if you reached a point in your business where you decided that you needed a mechanical engineer, for example, you went out in the field and obtained a mechanical engineer for whatever price you were required to pay for the desired talent.

Probably the earliest form of job evaluation, as we know it now, was the case of taking a partner in the business. Shortly after taking in a partner, we took on a salesman. The salesman, in turn, was paid on a commission basis, and his earnings or livelihood was in direct relationship to his ability to sell the product. The use of undeveloped plans for paying people resulted largely in inequities in plants between departments, and between plants, and also in geographical locations. With respect to geographical locations, probably the greatest today, is the North and the South differential. That is still in existence.

Also, we created wage rates and inequities through superintendents of departments and the managers of plants being held responsible for their costs in their entirety. They, in turn, established the rates that were paid the people, and all sorts of systems were set up to

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pay people to the extent that as long as their costs were in line, there were very few people who would criticize the rates they paid.

Then we had the item of personal hourly rates. A great many businesses would hire an individual and pay him a fixed hourly rate. After a short period of time, they might give him another nickel or another 2 cents, and this created all sorts of inequities of rates in departments to the extent that minor changes, that had very little effect on cost in the early stages, were pyramided to the point that we had inequities throughout an entire department. With these personal hourly rates, we found ourselves in the position oftentimes of having as many as twenty-five different rates on the same job with twenty-five people performing the same work or similar work within the job. That was not at all unusual.

The abandoning of jobs in departments without adjustment in the rates to the new techniques that were involved also contributed to irregularities in rates and inequities of rates, and this entire situation brought about all types of discontent among employees.

That we progressed as far as we have industrially with the wage payments that we have had over the period is remarkable. It is amazing when you stop and look back over what has happened and how people have been paid. Considering it from a department standpoint, a great number of lower rated people were infiltered, and as they went into the department, immediately the cost went up for a short period, through inefficiency, but as they became efficient we obtained cost reductions, and the overall effect was that as long as we were showing a profit, an increase in performance and a reduction in cost, everyone was pretty well satisfied.

Now, we have another phase of job evaluation that we want to look at for a minute, and that is the question of regularity of employment. Important items in connection with this, no doubt, are regularity of employment, income over the year, job security, and those items that contribute to a stabilized income or stabilized standard of living.

Among better examples of this would be in the case of the building trades industry. The craft jobs within these industries are, and have always been, substantially higher paid than the same craft jobs in other businesses. The reason that is advanced for this is that in the main the jobs are seasonal. They are irregular, and oftentimes there are long periods of time between jobs. Higher rates of pay during the periods when they are working would necessarily be expected. On the other hand, in other businesses where the rates are lower, where the employment is regular and there is a reasonable amount of security, where travel time to jobs is not a question, where they have such items as insurance plans and pension plans for service, these have all contributed to job security to the extent that substantially lower rates in many instances are reflected.

In that connection, if you were to consider Civil Service, for instance, which covers a multitude of various jobs, including engineering as well as clerical, the rates invariably are lower than those of private enterprise or private industry because of the security that they feel within the job, and the pension that they have after years of service.

In that connection, various industries have tried the profit-sharing plan. These profit-sharing plans worked all right as long as there was a profit, but when they reached the point when there was no profit, they were reaching into people's security to the extent that there are few, if any, of these plans left today. I believe I read somewhere not long ago that prior to the war there were some 185 profit-sharing plans throughout the country, and by the end of the war there were only about 20 of those plans left.

After the passage of the Wagner Act, in connection with this phase of job evaluation relating to security, our first union agreements did not deal nearly as much as they do today with such items as job evaluation. They dealt more along the lines of security from the point of view of union recognition, non-discrimination clauses because of union membership, seniority, and such items in the initial approach.

Such items as vacations with scheduled rates, large wage adjustments above common labor, severance pay, and so forth, were all secondary to security of a job and security of a right to work. Therefore, I believe it can be said that job evaluation deals with the individual and his livelihood, his standard of living, to such an extent that the two principal objectives should be security which covers seniority, promotional opportunities, and so forth, and, rates of pay and a return for efforts measured by some relative means of job importance.

Realizing the fact that job evaluation is a major item in connection with the individual and his livelihood, F. W. Taylor, prior to the first World War, was probably one of the first if not the first industrial engineer, or efficiency engineer as they were called at that time, who tried to evaluate jobs on the basis of time study. After the war, interest in evaluating jobs by time study became more prevalent among industries, and the results were that the control of cost by measuring work, or job evaluation, through time study were among the principal reasons that we were able to maintain the standards that we had established during the war.

The first application of job evaluation by time study provoked a storm in the ranks of labor, which was commonly known as the "speed-up," the principal reasons being that labor was not prepared for it at that time. They had no alternative but to accept it. However, regardless of the plans that might have been established at that time, the plans of job evaluation through time study were no better than the people who installed them, and very often they were misdirected, poorly installed, and, as a result, we set up a tremendous fear in labor to the extent that there was an act of Congress that provided that no incentive should be paid to any jobs in the Army, Navy or governmental services. That remained in effect until this last Congress, and I understand the last Congress just took that act off the books. Now they are installing incentives in certain governmental arsenals, laundries at naval bases, and so forth.

It would be wrong, I believe, to pass this phase of job evaluation without pointing out the fact that a great many rates were not set by time study. They were set on the basis of theoretical capacities of equipment, and very often they created substantial inequities as a result of being too liberal or too high. Also over a period of years, technological changes were made without correcting the rates, because at the time individual

changes looked small, but if we have a series of 2 per cent increases, shall we say, for a period of ten years and we put in twenty-five or thirty of them, we pick up sometimes as much as 50 or 60 per cent of aggregate increase.

We have been talking principally of industry as a whole. The steel industry has been no better than industry as a whole in this entire situation. Up until the time of our union agreements, we paid just about what we wanted to pay, where we wanted to pay it, throughout the mills. Then we came into our collective bargaining agreements with our employees. Among the first steps for production and maintenance employees was to set up a ten-cent-an-hour across-the-board increase in 1937, with a minimum of five dollars a day. During the period of 1937 through 1942, we added to this a total of 15½ cents an hour across-the-board. What semblance of job evaluation there had been was virtually eliminated at that point, because the adding of flat rates across the board detracted from the skilled jobs.

The union at that time was appealing to the masses who were the people in which they were particularly interested. They were not interested in what they could get for the machinist or brick mason or people of that category.In order to point out what this meant, this 15½ cents an hour, your 62½ cent man, received an increase of approximately 25 per cent, while your dollar-an-hour man received just 15½ per cent, so that we set up an inequity in this relationship of 8.2 per cent of what job evaluation had been left between jobs.

The 1943 negotiations with the union were terminated by sending the entire issue to the National War Labor Board after the Christmas strike of 1943. This included the union's twenty-odd demands of virtually everything. Among the items that were sent to the Board was an item of wage rate inequities, which they asked to have resolved by the Board. The union strategy at that time was that they had a friendly government and the more things they asked for, the greater would be the percentage received.

The National War Labor Board, in turn, put out a directive order stating that something should be done about this question of job evaluation. I would like to quote a section of that:

"The union requests the Board's approval of a principle stated as equal pay for similar work throughout the industry to be used as a guide in collective bargaining for the elimination of wage rate inequities. This request of the union is denied because the phrase has been so variously interpreted by the parties that it would not be a useful guide and because interpreted to mean industry-wide stabilization of wage rates, the principle will be contrary to the terms of Executive Order 9328 in the May 12 supplement of the Director of Economic Stabilization.

"The problem of adjusting inequities in interplant wage rate relationships in this industry is one of long standing. Previous contracts with many of the companies provided machinery to adjust such wage rate inequities. In some contracts a joint union-management commission was agreed upon to develop a procedure for the purpose. The commission failed to find an answer to the problem, largely because of lack of agreement to the extent to which the adjustment of interplant wage rate inequities should affect pay rolls.

"The National War Labor Board has been asked to specify guideposts to facilitate collective bargaining to the solution of the long-standing problem. The company and the union shall negotiate the elimination of interplant wage rate inequities and the reduction of the number of job classifications in accordance with the following steps:

1. Describe simply and concisely the content of each job.
2. Place the jobs in their proper relationship.
3. Reduce the number of classifications to the smallest practicable number by grouping those jobs having substantially equivalent content.
4. Establish wage rates for job classifications in accordance with the provisions of paragraph D below.

"The following guideposts are established for collective bargaining:

"The extent of wage adjustments required to eliminate interplant wage rate inequities will vary between companies. From the record, it appears that little or no increase to eliminate interplant wage rate inequities will be needed in some plants where wage rates are now in sound relationship.

"The largest increase in pay roll costs may be expected where little or nothing has been done in the past to correct wage rate inequities.

"The maximum increase for any one company shall not exceed an amount equivalent to 5 cents an hour for its employees covered by this directive order.

"The wage adjustments, which may be made solely for the purpose of eliminating interplant wage rate inequities, cannot be general across-the-board increases, and any such general increase will be disapproved.

"As an aid to determining the correct relationship between jobs and a particular plant, the company and the union may take into account the wage rate relationships existing in comparable plants in the industry.

"The contention that wage rate relationships for the plants in the industry have no significance for this purpose is rejected.

"The reduction of out-of-line wage rates shall be effective to reduce the wages of present incumbencies."

The National War Labor Board having established guideposts in the steel industry then for the elimination of intraplant wage rate inequities, the industry as a whole had no alternative but to get into some sort of a plan for evaluating jobs. As a result of this, a group of the various companies of the industry got together in a cooperative wage study and a start was made to appraise the various problems that would be involved in the program.

In order to appraise the various problems, attempts which had failed on so many other occasions, the group first started out to find out what was their problem. They found that they had all types of rates, all types of guarantees, and the problems were just about as many as there were companies participating. Everyone had their individual idea of how people should be paid, and it was quite a task and there were many hurdles that they had to overcome in order to reach what was finally agreed upon as an acceptable result of this study.

In order to give an idea of what was involved in this,

the first step in connection with carrying out the order was to develop job descriptions, and these job descriptions involved some 77,000 total jobs for approximately 25,000 different jobs. These job descriptions were then grouped by operations in order to segregate what might be considered similar jobs. In that connection, a system of coding was set up in order to identify what were substantially similar jobs.

After these jobs had been grouped and they found what similar jobs looked like, pay roll statistics were used for all of the jobs to appraise the value of the similar job base rates and average hourly earnings where incentives had been applied to jobs. One would think that that was a simple job, but there were 77,000 of these jobs and 25,000 different jobs, and pay roll statistics were brought up to date on all of those jobs in order to attempt to appraise what might be involved in the problem.

Now, in that phase alone, the problem started to unravel. First, you might take a rather simple job — and bear in mind whatever came out of the situation, the union was going to have to be negotiated with in the end in order to make it successful — that all plants would have very few variations in, such as a ladle liner, and see what a proper rate should be for a ladle liner. It was found that the rates of a ladle liner varied from 78 cents an hour, which was common labor at that time, to $2.75 an hour in the case of a ladle liner that was tied in with an incentive arrangement. That is just one example, and very nearly all of the jobs were of that type with substantial and wide variations in their rates.

After these pay roll statistics were received and the rates of the similar jobs had been reconciled, the results of the correlation of the rates on the similar jobs in the industry indicated these wide variations. About the only factor that all of the participating companies in the corporative wage study were agreed upon at this stage after substantial work had been done was that there was a great need for job evaluation of some type, no one knowing what the type might be.

Those charged with the responsibility of establishing a manual of standards for the classification of these jobs reviewed what had been done in the past to see if in those cases there was anything adaptable to the industry. They found many plans, approximately a hundred, some very simple, some complex, and found that there were none in existence at that time that would be adaptable to the steel industry for the evaluation of the jobs of the industry under the terms of the guideposts that had been established as a result of the National War Labor Board directive order.

The plan that was finally developed and finally agreed upon by the participating companies involved consisted of twelve factors considered for each of the various jobs of the industry. The factors of the plan were:

1. Pre-employment training.
2. Employment training and experience.
3. Mental skill.
4. Manual skill.
5. Responsibility for material.
6. Responsibility for tools and equipment.
7. Responsibility for operations.
8. Responsibility for safety of others.
9. Mental effort.
10. Physical effort.
11. Working conditions.
12. Hazards.

That manual unquestionably had a great many items in it that were not satisfactory to all of the people participating. I know there are items in connection with it that I do not like today. I know that a number of the other people that are using it are not happy with many of the items, but it was a consensus, shall we say, of the best applicable plan at the time.

After a plan had been developed, we had these 25,000 different jobs to evaluate, and in order to make a start at this, 143, I believe it was, bench-mark jobs were segregated, or jobs that should have substantially equivalent contents to use as guideposts of relativity for other jobs within the various factors.

The mathematical weights of the various factors were set up by a statistical analysis of the 143 bench-mark jobs, which gave a reasonable cross section of the total. I mentioned previously that we had to negotiate with the union. In negotiating with the union, they immediately took exception to certain of the bench-mark jobs and we had our troubles there, and they were many, because the union was suspicious all the way through.

There are a great many people today who believe that job evaluation goes beyond the question of evaluating the jobs as performed and that, in the performance of the jobs, consideration should be given to other items in connection with the evaluation of jobs that require a variety of considerations that are not routine, jobs that have various factors that are, shall we say, mental to the extent that questions of degree are involved.

In so far as job evaluation is concerned, I believe it is a fair statement to say that a numerical or a point system of evaluating jobs can be adapted where jobs are substantially routine, such as production or maintenance jobs, possibly certain other types of clerical jobs, and so forth; but in order to carry that to an extreme, I know of no way, nor have I heard anyone who has had a successful means of evaluating jobs, such as for example engineers, where mental factors are involved. Today we have a substantial shortage of engineers, and I do not know of any way we are going to evaluate the value of engineers, except on the basis of supply and demand. The entire question, I believe, of job evaluation as a whole hinges around the fact that in job evaluation we are dealing with a highly technical subject in so far as the buildup is concerned, and that if we are going to be successful in the future in the steel industry in keeping out wage rate inequities and not getting into the same position ten years from now that we are in today, we are going to have to maintain these job evaluations. We are going to have to make corrections as jobs are changed, as new equipment is installed, or we are going to find that in ten years we are going to have just as many inequities as we had previously to the time we got into this program.

I would state that in connection with the question of job evaluation as a whole, it should be done by those people who are especially trained in the subject and the plan, whatever plan it might be, should be maintained after its original installation in order to prevent new inequities appearing at some later date.

DISCUSSION

PRESENTED BY

HOWARD BISHOP, Youngstown Sheet and Tube Company, Youngstown, Ohio

FREEMAN H. DYKE, Assistant General Manager, Wheeling Steel Corporation, Steubenville, Ohio

JOHN H. VOHR, Assistant General Superintendent, Carnegie-Illinois Steel Corporation, Chicago, Illinois

L. H. BROWN, Chief Industrial Engineer, Wheeling Steel Corporation, Wheeling, West Virginia

Howard Bishop: I would like to point out that in job evaluation you do not have an exact science. It cannot be. A lot of good common sense has to be injected into it and the factors of good reasoning.

If you do have a logical plan and it is carried out in logical sequence and the various factors as enumerated here are given consideration, you will come out with very sound rates for the industry. I feel that, by and large, the industry will be much better off than we were in the past if we follow logical plans.

I think industry has progressed in the technique of rate establishment, particularly as it applies to their dealings with the union, but we are still in need of more technical work in the field of rates, and their relationship to supply and demand.

I might point out that an evaluation plan will involve two things, first, the point rating of the jobs, and, second, the determination of a wage scale which can be varied according to the supply and demand factor or the general economic pressures. The same job, if it is properly classified and is maintained for any changes in job content, may this year have a certain monetary value, and ten years from now it may be more; it may be less.

We have at least established a workable plan which is a sound starting point for the steel industry to frame its rate structure, and I think that we will have a much more satisfactory rate situation in the future than we have had in the past.

Freeman H. Dyke: The Association of Iron and Steel Engineers has seriously been considering the idea of establishing a section of industrial engineering, corresponding to our combustion, operating, rolling mill sections, etc.

Industrial engineering is such an important phase of our engineering practices that I think the establishment of such a section would be well worth while. I sincerely hope that papers and discussions of this type will be continued as part of our regular Association meetings.

Mr. Brown spoke of security as being most important. Of course, all of us, as individuals, are working for this. Up until the last seven or eight years, security for hourly rated people in the steel business has been lacking. When times were good, everyone worked hard and continuously and made money. Then operations would slow up and there would be extended lay-offs. Naturally this was a bad condition and people lived more or less from hand to mouth. The last seven or eight years have been booming and we have had practically full operations.

We must exert every possible effort to make low cost product so that such conditions will continue. Previous to the war, labor had either a feast or a famine.

Mr. Brown mentioned that profit sharing plans have been decreasing in recent years. Personally I think this is regrettable. There are many variations of profit sharing but all are based on the same general principle, which is reward for achievement.

In spite of all the good work that has been done on job evaluation, in our opinion not enough emphasis has been placed to date on the responsibility part of the job. We see jobs in the maintenance, as well as the operating fields, where very careful time studies have been made. However, when a man is working on an incentive plan, based on these time studies, in order to make the maximum possible earnings he may waste much material. A maintenance man, in order to speed up a job that is not necessarily affecting production, can destroy much material with a burning torch, whereas the use of a wrench (while of course taking more time) would save much material.

In the same manner an operator of a mill or machine, who is not compensated for high yields, may destroy or fail to salvage valuable products in order to get out more tons per hour. We think this part of the study should be emphasized, and possibly a careful workman should be rewarded more than he is at present.

Mr. Brown stated that there are many differences of opinion on the various items which go into evaluation of a job. We have merely named one of these which came to mind. The job of evaluation in the steel business has made remarkable strides in the last few years. More and more details are being written into job description today, but no job unless it is relatively simple can be written up in detail to cover every eventuality. It is most important that this be done as completely as possible because none of us want to hear what we have so frequently heard in some places in the past, that "this is not part of the job."

John H. Vohr: We have heard a lot about the so-called Grant Street Committee together with the theory of a fair day's pay for a fair day's work. I would like to ask the relationship between this subject and that of job evaluation and if there is such a relationship, if Mr. Brown has been successful in tying the two together.

L. H. Brown: Mr. Vohr has raised a question that is subject matter for an entire meeting. Having evaluated the jobs in relationship to one another gives the rate of pay for a fair day's work. Receiving the fair day's work is a duty and responsibility of supervision.

The industrial engineers can be of help to supervision in this matter to the extent of establishing values in time on certain operations that are helpful, however the burden of receiving a fair day's work is still an operator's major problem.

Howard Bishop: There are today many ramifications and countless rates. The job classification plan has simplified the rate structure and reduced them in number to thirty with about twenty-eight active rates, which shows some progress in rate policy.

METALS IN SERVICE

By P. M. HESS, Station Superintendent
Safe Harbor Water Power Corporation
Conestoga, Pennsylvania

. . . . the proper application of metals to meet required service conditions requires extensive knowledge of the metal in service, the proper selection to meet the service condition, and careful installation . . . .

▲ MANUFACTURE, make or treat metals according to scientific data for a specific job and users expose them to the forces, stresses and elements in various manners after most careful consideration. Engineers have no doubt made some errors at times in their specifications, the manufacturer has at times erred in his procedures and the users have also at times erred in their application. In order to arrive at the perfect solution to any problem there must be close cooperation between these three parties, namely the specifier, the manufacturer and the user. In this paper, my company has been placed in the position of the user and, the paper presents some small part of the problems encountered, and points out some places where we have chosen metals incorrectly, some places where we have placed them in the wrong combination, some places where we were correct in our selection, and then again some more places where our selection was correct but the product inferior. Only by actual service are some of these problems solved, and it is hoped therefore that by numerous illustrations, knowledge will be advanced in the broad picture of what the future holds for metals.

The subject "metals in service" does not refer to the military angle that it might suggest, it refers to the problem encountered in actual every day life. When we build for military purposes, costs are not considered and long life is of lesser importance. The experience with metals referred to in this paper is the result of twenty-five years service in the steam and hydro-electric field with the Pennsylvania Water and Power Company and Safe Harbor Water Power Corporation where metals are required to perform many tasks. In our phase of the business, and in the majority of the uses for metals, costs and durability are of prime importance. With the initial cost of existing materials increasing, we must provide better products at the same or lesser price. With maintenance labor and materials cost going higher and higher, products must be made more durable. It is better to provide good products and adequately protect them initially, than to repair and maintain them often. Continuous service, void of outage for maintenance and repair, is of paramount importance in the electric industry.

About twenty-five years ago, if it had been suggested that metals could be developed to withstand some of the conditions to which they are subjected today, we probably would have believed the idea to be fantastic. Yet today we are doing perhaps better than one ever dreamed of in the past and the end is not yet reached. For example in about 1920, steam plant men would have marvelled at the present operating pressures and temperatures now successfully employed — 1050 F and 1500 psi. Even higher temperatures and pressures are being considered. These have been made practical only by the development of metals able to withstand the conditions existing at those figures. The gas turbine and jet engines are opening up even more fields for this type of problem.

The men in the plastic field are trying, wherever possible, to substitute their product for metals. At some places they have been successful and at other places the task, at present, seems too difficult. There is, it is

Figure 1 — Severe ice conditions, such as those illustrated, necessitate the solution of many problems by the materials engineer.

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 25, 1947

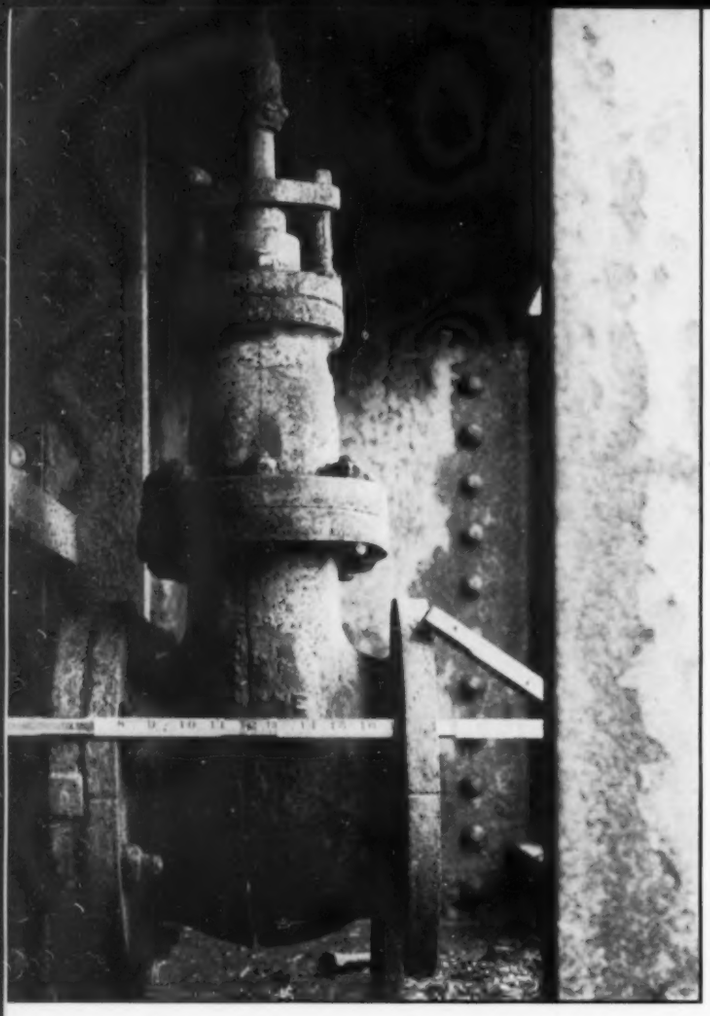
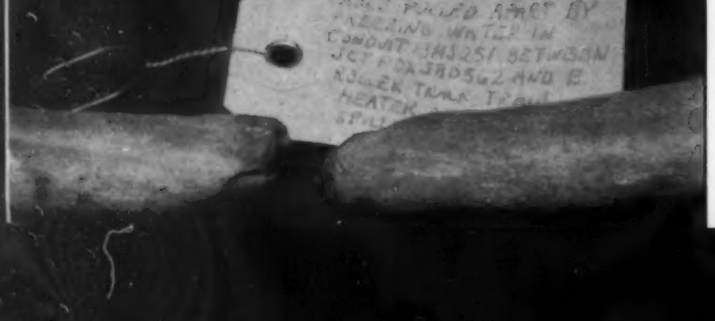


Figure 2 — Expansion due to freezing cracked this 8 in. gate valve.

believed, a big field for the development of materials utilizing a combination of the two products, and no doubt efforts along this line are already exerted. Close cooperation between the two industries should be encouraged.

Much has been accomplished in recent years with the use of organic coatings for the protection of metals against corrosion, utilizing vinylites, rubbers, alkyds and phenolics. Some of the now better known procedures utilize a combination of metal dusts and oxides in phenolic and alkyd resins, and have been developed only after a long test program where the materials are subjected to actual service conditions. It has been

Figure 3 — In this case, a 2 conductor cable pulled apart because of water freezing in the conduit.



learned that every problem is different, and that adequate protection requires a different procedure depending upon the type of water or liquid in contact with the surface, the weather conditions, the mechanical fatigue, the electrical field and all the other factors present that contribute to failure.

Problems in each section of the country require an entirely different approach for a solution, due to the temperature, humidity and cycles of temperature change, yes, and the rate at which these changes take place. Pennsylvania is a section of the country where the number of cycles and degree of temperature changes are perhaps as bad as can be encountered anywhere. This condition demands that most installations must be engineered to withstand these reversals. Our highways, for example, receive many cycles of freezing and thawing during a winter and perhaps in one year are subjected to as many as a Canadian or Florida highway receives in twenty years. A similar problem is encountered when designing and building bridges, pipe lines, railroad tracks, in fact anything built of a material which has an appreciable coefficient of expansion. Recently it was noticed that the rollers under a long steel railroad bridge were worn out from these expansion and contraction movements, and at one place a roller had been pushed out of position completely. This bridge has been in service 48 years. The airplane must be designed to withstand these changes perhaps more than most of our present day equipment due to the sudden changes in temperature and the reversal of stresses. These expansion problems are always present and must be considered even when using organic coatings as protection. The damaging effect of the rapid rate of change upon materials must be strongly emphasized.

Metals have many applications and are used as solids, liquids, dusts and even practically as a gas. This fact permits a diversified application of metals. Materials fabricated from metals further lend themselves to comparative ease of repairs which is so necessary for maintenance purposes. Therefore, we weld it, we mold it, we spray it and we shape it almost to any conformation desired. We as users naturally are interested first in a maintenance free product, and if maintenance free is not possible, to be so fabricated as to permit ease of repairs. So often this ease of maintenance angle is forgotten and when repairs are required under difficulty, adverse reports are forthcoming from a product which is not too much out of line for the service it is required to perform. Do not forget the maintenance man when fabricating and designing equipment.

The various pieces of equipment in a hydro-electric plant are, in general, fabricated from metals. This equipment includes turbines, generators, transformers, flood and stop gates, water and electric conduits, trash screens, railings, gratings, reinforcing steels, enclosures, gantry cranes, etc. None of this equipment is maintenance free. A few of these problems (in which metals are involved) will be discussed, pointing out how some have been caused, what results, what has been done to correct some of them, a few tests which are under way, some problems which are still unsolved and some few recommendations for improving similar jobs in future work.

In the hydro-electric plant, metals are called upon to perform many different tasks, but the one more often

brought to our attention, and still not completely solved, is that of corrosion. Corrosion is the enemy of most of our ferrous materials and is caused more generally by the presence of moisture in some form. Moisture is a necessary part of a hydro plant so naturally combating corrosion is one of our biggest problems. Since a large part of the spillway section of the dam structure is composed of gates fabricated from ferrous steels, the corrosion item must be coped with almost continually. Much experimentation to combat corrosion has been carried out in the past ten years and a great deal has been learned. The problem was difficult and interesting because of the many service conditions encountered in the local river water. The Susquehanna carries mine and industrial acids, and much silt and floating timber at certain times of the year. However, the greatest enemy of the protective coating is the action of sheet ice at times when the protective film is most brittle. We are now in the midst of confirming some of our early conclusions and are happy to believe that a comparatively simple and not too expensive procedure will relieve our earlier headaches.

Next to corrosion, the problem of pitting resulting from cavitation is an item to be placed high on the list. It seems that when one has a difficult problem to solve and the task looks hopeless, all that is necessary to solve it is to get all minds concentrated on the problem, especially the manufacturers, research men, and users. This is just what was done in combating the problem of cavitation. First it was necessary to find out what caused it and then correct that condition as best possible. The next was to apply a material or metal to the vulnerable places capable of withstanding the existing cavitation that could not be eliminated by other means. Many simple procedures were tried but it appears, at present, that where cavitation is severe the best solution is to weld a layer of 18-8 metal over the affected areas. Some other forms of stainless have been reported as satisfactory, but our experience still advocates the 18-8 except for certain specific cases.

At the time of building Safe Harbor Plant, Kaplan turbines (adjustable propeller type) were installed that had approximately eight times the capacity of any previously built in the U. S., and of somewhat greater capacity than any in existence. Because of the high operating speed (specific speed) of these runners, and corresponding high water velocities, it was expected from experience of other companies that pitting caused by cavitation would occur in local spots at an early date. This did occur after about three months of operation in 1931 and 1932. Lack of experience with welding stainless steel forced repairs with mild steel, accompanied by some reshaping to reduce local cavitation. After about one year these mild steel welded areas started to pit again but to a somewhat smaller extent and volume due to the improved shape. After approximately 18 months the pitted areas increased so much that a comparatively elaborate welding program was necessary.

From experience in welding cast iron runner blades with stainless steel in the Holtwood plant of the Pennsylvania Water and Power Company, it was decided, if possible, to weld all pitted areas on these Safe Harbor runners with the 18-8 stainless steel (18 per cent chrome, 8 per cent nickel) which proved satisfactory on

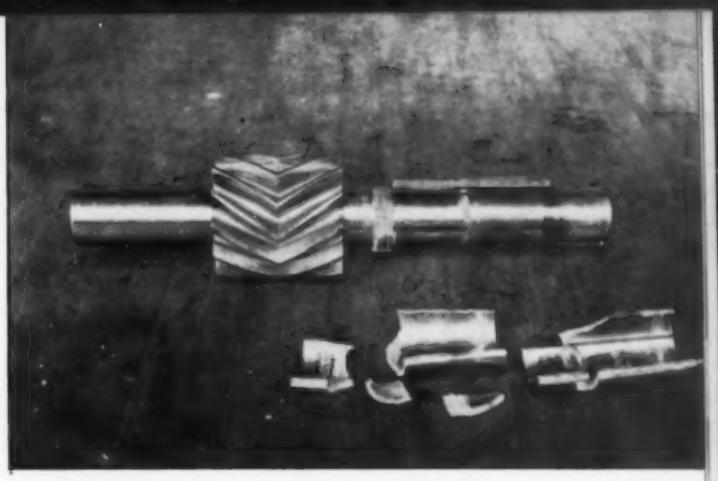
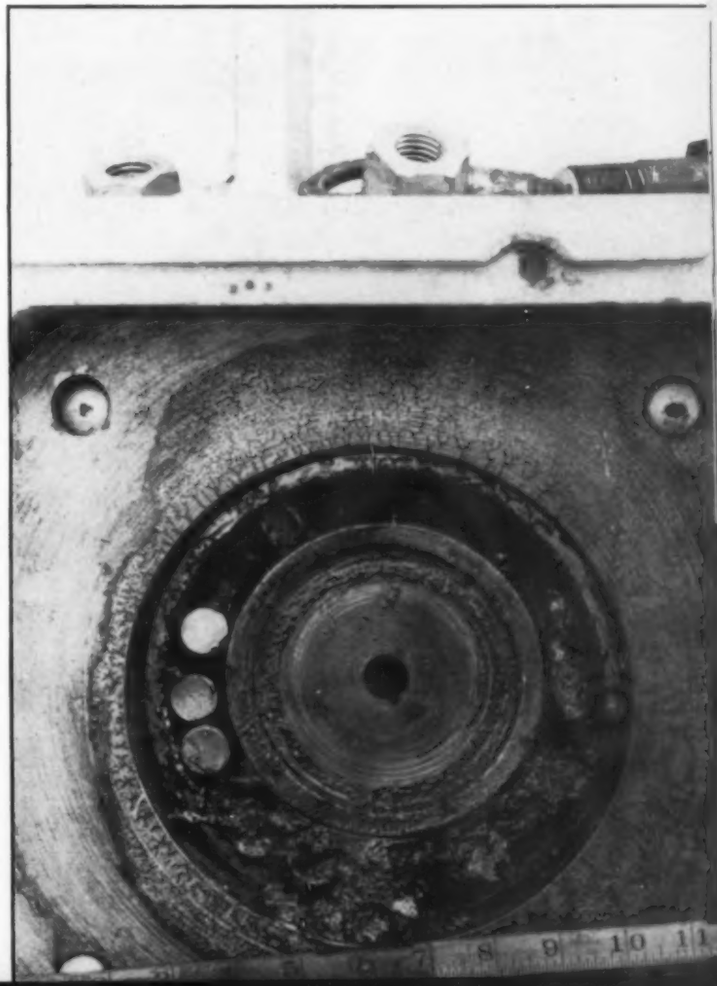


Figure 4 — This drive gear shaft on a governor pump was damaged because of a momentary loss of lubricant.

the Holtwood runners. In order to determine if our runners could be welded, blocks of steel with the same specifications as that of the turbine blades were purchased. On these blocks trials were made with various types of stainless steel rods, for flat, vertical, and overhead welding, with emphasis placed on overhead welding, because most of the affected areas existed on the suction or underside of the blades. Data was secured on the depositing characteristics of each wire, its ability to bond to the parent metal, shrinkage tendency, currents and voltage required, ability to chip the pitted areas, machining and grinding characteristics of the welded metal, types of grinding wheels and grinding

Figure 5 — Dirty lubrication will result in maintenance problems.



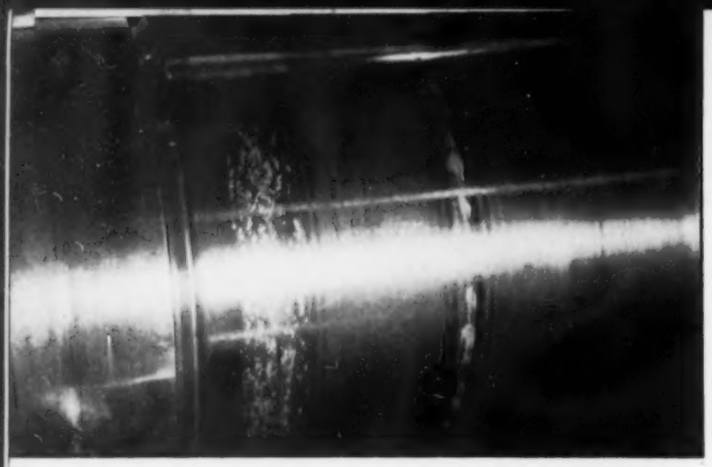


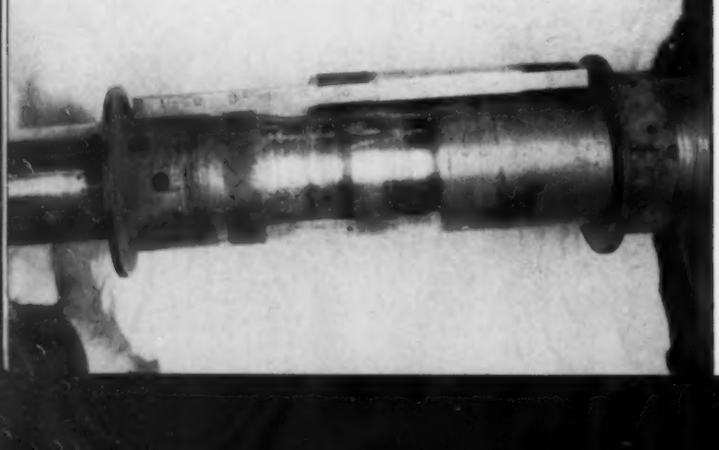
Figure 6 — This bearing was pitted because of shaft currents.

tools required to refinish the welded areas. From results of these tests, welding rods, grinding wheels and chipping hammers were selected for the job. As the job progressed, the tools and procedures were improved to the point that now the repairs are considered a comparatively simple job almost on an equal basis with painting. Stainless steel welding rods of the proper analysis and proper coatings were in their early development stage. Our selection at that time was fortunate because no field welding has ever required rewelding chargeable to the type of rod used. A prewelded job (stainless rod high in carbon) did not withstand the blows of cavitation and had to be rewelded after several years of service.

The corrosion problem was approached by attempting to learn as much as possible from other companies having similar installations of gates, and under water equipment. No one seemed to have the solution and generally speaking each had a different, more or less, pet process. About all that was learned was that hundreds of processes are available and apparently all of them are supposed to handle the job with ease. There was only one thing left to do and that was to experiment. Consequently, many samples were applied to the large flood gates and the tests expanded from year to year, always applying in addition to the new test specimen, the better samples of the previous tests to the newer test gates in order to have a positive means for comparison. To date practically every known type of material has been tried and a few of them have now been rated as very good.

In general, the new phenolic and alkyd products

Figure 7 — The inboard packing sleeve on this pump was worn because of a rough type of packing.



using red lead — zinc dust-zinc oxide and zinc tetroxic chromate pigments in the correct ratios are providing excellent protection even without the use of an inhibitor. The inhibitor, however, has in most cases more than doubled the life of some paints. At present, satisfactory protection is being provided by the use of sand blasted, inhibited and three coat sprayed processes even when subjected to the severe punishment of ice movements. This type of protection is doing a job comparable to other much more costly procedures with test life now in excess of seven years.

The effect on metals resulting from their exposure to some of the elements and conditions encountered in service is enumerated by a few illustrations.

Figure 1 illustrates the severe winter conditions encountered in this locality and portrays the problems which must be considered when designing equipment to withstand the extremes experienced. Ice conditions such as this occur during the approach of a cold wave prior to the freezing of the pond, and are experienced only when the prevailing wind is in the direction of the dam. Many dams of course are so built that the prevailing wind at the approach of a cold wave will be in the reverse direction so conditions such as these shown are not experienced. These conditions are caused by spray from wind and waves during sub-freezing weather.

Figure 2 shows the result of conditions which are difficult to solve, such as valves and pipes full of water exposed to freezing conditions. Problems such as these

Figure 8 — Comparatively little wear is seen on this turbine shaft packing sleeve because care was used in the initial selection of the packing.

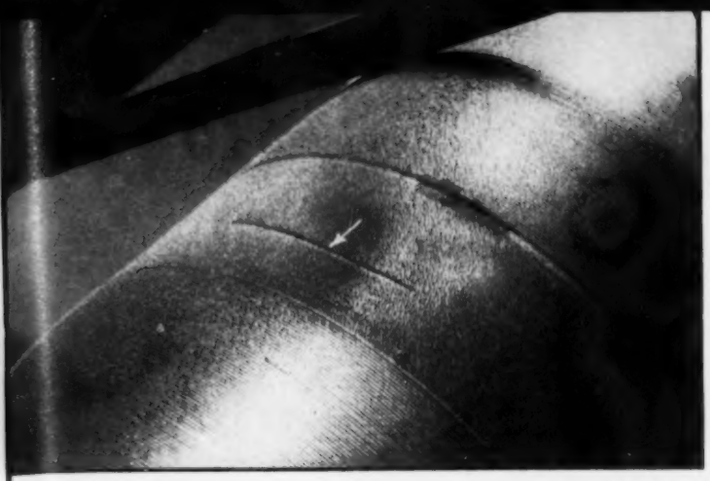


Figure 9 — Stress concentration caused this crack at the crosshead shoulder of a blade operating shaft.

must be considered in designing, so that the equipment will not be subject to freezing with the resultant expansion, against which it is practically impossible to provide materials capable of withstanding the forces.

Figure 3 shows the results of expansion and contraction. Condensation and water accumulations at low points in conduits where temperatures are such that the water will freeze must be eliminated. The repeated freezing and thawing causes the complete breakage of lead covered cable which might be installed in them.

Figure 4 shows what happens when the lubrication medium between metals is lost. This represents a cast iron sleeve on a polished steel journal operating under very high bearing pressures. The momentary loss of the lubricant results in the "freezing" of these two materials.

Figure 5 shows what happens when the lubricating medium becomes contaminated or dirty. This shows a roller bearing on a gantry crane bridge truck in which dirt entered through the seals. Metals will not function satisfactorily with dirty lubricants.

Figure 6 represents the result of shaft currents circulating through a bearing. The flow of the current causes pitting of the metals, and if the flow of current is allowed to exist for a considerable time, depending upon the amount of current flowing, failure of the bearing is inevitable.

Figure 7 represents the packing sleeve on a pump worn from the use of a comparatively rough or abrasive type of packing, accompanied by dirty gland cooling water. These conditions are rectified by building up the worn areas with sprayed metal, using a harder material, or supplying initially a sleeve of a superior metal and packing of a less abrasive nature.

Figure 8 represents a stainless steel sleeve on a large turbine packing gland in service five years, which is worn only slightly, and demonstrates the advantage of selecting the proper type of metals initially. This same sleeve is still in service after fifteen years of exposure to comparatively dirty river water.

Figure 9 represents a crack in a large shaft, discovered by the use of magnaflux, and resulted from fatigue as a result of concentration of stresses. In designing, this concentration of stresses must be given serious consideration.

Figure 10 represents the bad selection of metals retaining a sealing strip on a water submerged gate.

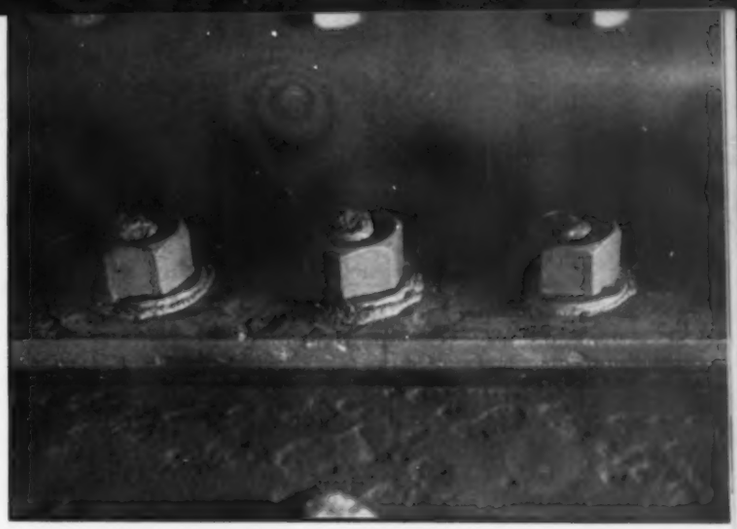


Figure 10 — As shown in this photograph, designing a nut and bolt of dissimilar metals may cause serious corrosion problems.

The dissimilar metals, one ferrous, the other non-ferrous (the bolt of one material and the nut of the other), sets up a battery reaction and one metal suffers at the expense of the other.

Figure 11 represents a seal retaining design which is bolted to steel with steel bolts and nuts. Behind the retaining strip is a large bronze strip spring seal. The bronze spring is responsible for the electrolytic action which is accelerating the corrosion.

Figure 12 represents electrolysis on a lead cable which action took place within less than two years of operation. In one location the lead was completely punctured. This condition was corrected by the use of cathodic protection, using dry cell batteries as the potential medium. This simple application has resulted in no increase in the pitting from electrolysis and the cable has been in service now for ten years.

Figure 13 represents the interior of a storage water tank to which cathodic protection has been applied. Cathodic protection to these elevated water tanks is a perfect solution if properly applied. The interior design of the tanks, however, makes each problem different and therefore must be solved individually. The distribution of the current to all metal parts must be fairly uniformly distributed, otherwise adequate protection of all parts or surfaces will not be obtained.

The problem of protecting under water equipment, primarily flood gates, head gates and draft tube gates is one of major proportion, especially the large flood

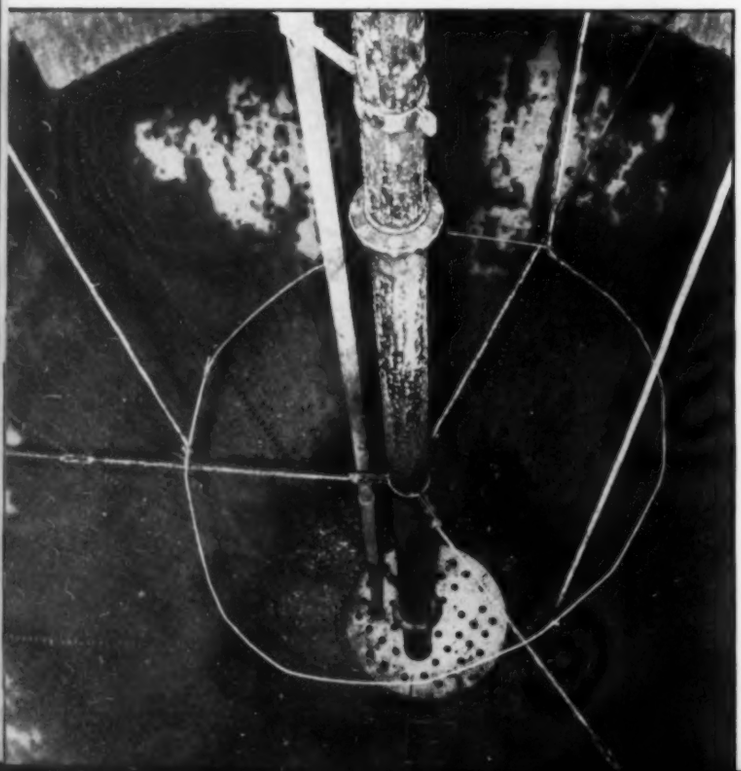
Figure 11 — A bronze strip in contact with the steel is responsible for the rusted condition at the end of this head gate.

Figure 12 — This grounded cable is seriously pitted because of electrolysis. The section of the cable shown is approximately 36 ft away from the fault.

gates. These flood gates are fifty feet wide and approximately thirty-six feet high or 1800 sq ft on the upstream side and of riveted construction. Due to the severe conditions to which the upstream surfaces of these gates are subjected, such as wave action, trash damage and the severe punishment received from the action of ice when ice pushes arrive at the dam, and further as the gate is being opened to discharge water, protection of the surface is difficult. The onrush of the ice against the gate subjects the protective coating to extremely severe punishment. A large scale test program was started in the early days and this Figure 14 shows the typical arrangement of the various samples for carrying out this test. It will be noted that some samples are affording excellent protection, while others are completely unsatisfactory.

Figure 15 represents a view of one of the large flood gates, in the repair bay, being coated with hot sprayed metallic zinc. Metallic zinc has been found to do a comparatively good job on these gates for a period of seven years with a coating thickness of 0.010 in.

Figure 13 — Cathodic protection illustrated in this photograph gave good protection to this 100,000 gal water tank.



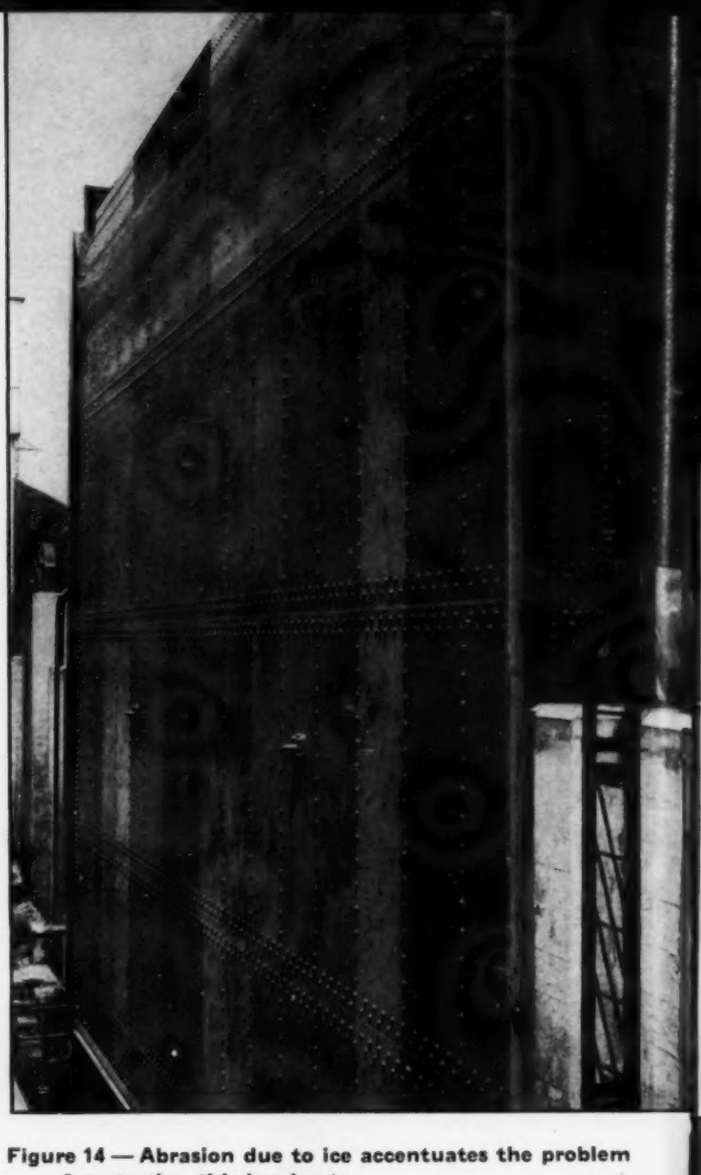


Figure 14 — Abrasion due to ice accentuates the problem of protecting this head gate.

Experimentations with zinc indicate that where the water is not moving rapidly across the surface, the zinc will provide protection in the waters of the Susquehanna river for about seven years. However, where water is passing across the surface, such as intake trash screens, turbine blades, and turbine gates, the application of hot sprayed zinc in our case is not a satisfactory solution. Less than one years service was received from applications on above equipment whereas seven years service was obtained on a flood gate.

Figure 16 represents failure of zinc coatings on flood gates at even an earlier date than seven years due to the presence of a bronze sealing strip along the vertical edge. This bronze sealing strip sets up a galvanic action which gradually destroys the zinc coating and progresses away from the junction of the zinc and metal in proportion to the conductivity of the water. This type of deterioration has been retarded by using an insulating paint over the metallic zinc, such as a zinc-dust zinc-oxide or red lead in synthetic vehicles. Further experimentation has been started and some results have already been enumerated on the value of painting over a zinc coated surface initially. No final statement can be made in this respect as yet since tests have only been

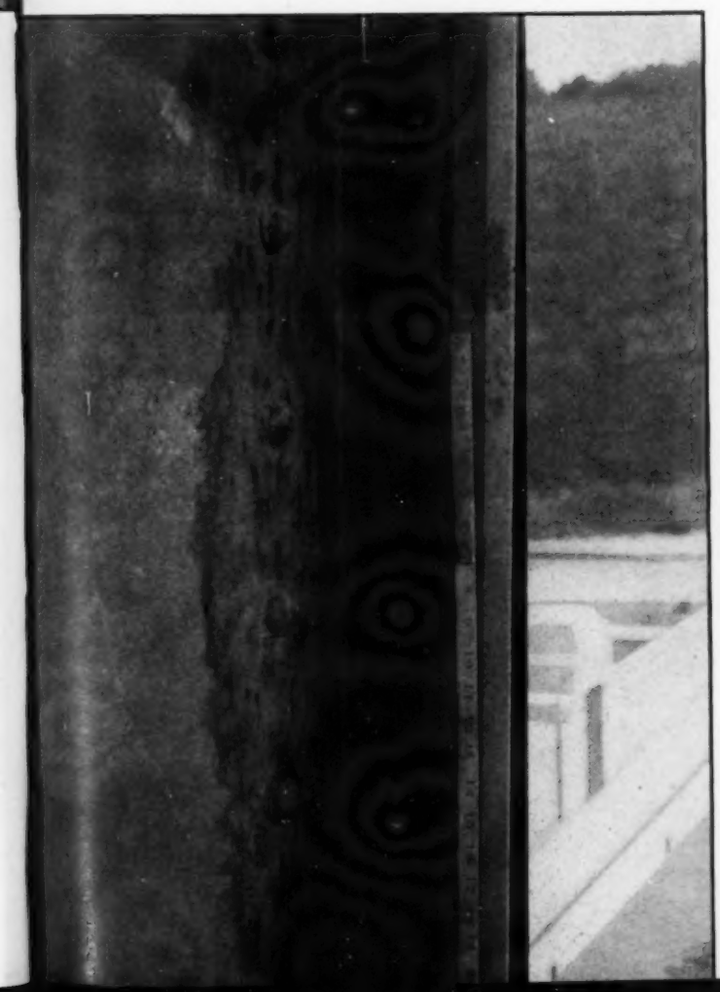
Figure 15 — Hot sprayed zinc gave good protection to this gate where water did not move rapidly across the surface.

under way for three years, however, promising service is anticipated.

Figure 17 represents the manner in which the zinc coating on the gate fails after eight years of service. The failure naturally starts at the point where the zinc application is the thinnest.

Figure 18 shows the surface of a flood gate coated with a hot bituminous product of one of the better types. Early experimentation with bituminous products showed some promise and in 1945 an additional gate was prepared for a test using one of the later products. This type of material is entirely satisfactory, we believe, in localities that do not experience the extreme temperatures and mechanical punishment from ice as that

Figure 16 — A bronze sealing strip set up galvanic action along the seam of this spillway gate.



suffered at Safe Harbor. The figure shows the cracks in the product and the damage to the coating over the rivet heads resulting from winter conditions. This type of bituminous protection should be very satisfactory for head gates, draft tube gates, etc., where the mechanical action is not present even though low temperatures are experienced.

Figure 19 shows the corrosion that has taken place on a head gate in a period of approximately ten years. These gates when built were protected with the conventional red lead then available and coated with a thin cold bituminous compound. This combination of red lead and bituminous compound was not satisfactory and resulted in early corrosion. It is better to use the bituminous compound directly on the prepared surface, preferably sandblasted or its equivalent.

Figure 20 represents the upstream side of a head gate which is used to close the opening of future units. It is exhibited to show the effectiveness of mud in providing protection to the metal. The lower half of this gate, which had a mud deposit in front of it, is in almost perfect condition, whereas the upper part, unprotected from the mud, has comparatively severe pitting.

Figure 21 shows the wise selection of stainless steel pins and rollers equipped with bronze bushings as the bearing material for the thrust rollers on the roller type head gates. Even though the wheels themselves are considerably rusted there is absolutely no deterioration to the pin and bushing which is lubricated by a pressure grease system.

Figure 22 shows the lower side of the leading tip of a turbine blade which has been protected against the forces of cavitation by the use of stainless steel. It will be noted that the stainless steel is withstanding this

Figure 17 — This test panel of 0.01 in. zinc spray failed after 8 years of service.

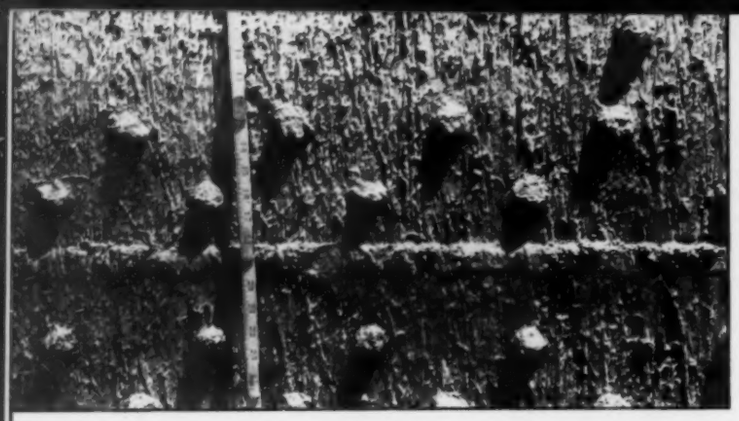


Figure 18 — Winter conditions caused the failure of the bituminous enamel applied to this spillway gate.

action, however, due to the somewhat improper shape at this point, cavitation is still existing back of the stainless steel with the resultant pitting of the present mild steel as shown in the figure. This cavitation can be reduced by changing the shape of the entrance edge somewhat or combated by the application of additional stainless steel over the pitted areas.

Figures 23 and 24 show close-up views of the pitting resulting from cavitation along the periphery and the trailing suction side respectively of a hydraulic turbine. These are very typical views. This type of pitting is combatted by chipping out the damaged metal, welding

Figure 19 — After 10 years of exposure, this head gate was corroded as shown in the photograph.

Figure 20 — Emergency head gate after removal from head gate slot. Notice corrosion above mud line.

with a good quality stainless steel rod, grinding and polishing to contour. Areas like these were repaired in 1934 with a present service of thirteen years and are still in first class condition, whereas the failure of the parent mild steel, indicated by the figures, occurred in less than three years.

In addition to the cavitation which exists on the surface of the blades, the action of cavitation takes place also at locations extremely difficult to repair. Figure 25 shows the pitting resulting from cavitation on the journal or trunnion of the blade where it enters the hub proper. Since at present we have found no means for

Figure 21 — The pins and bushings on these gate rollers, which are made of stainless steel, show no deterioration.

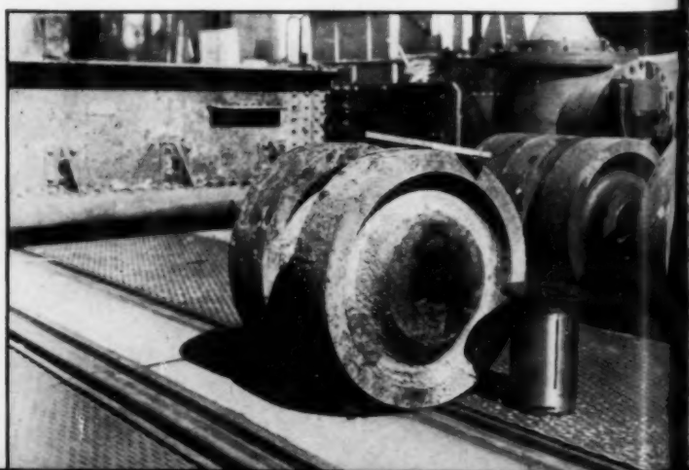


Figure 22 — Stainless steel helped considerably to withstand the pitting on the leading tip of this turbine blade.

grinding the weld at this location, it is still necessary to repair these areas by using a mild steel rod and finishing the surface by the use of long handled files. There is a need for a satisfactory stainless steel which can be finished without the use of a grinding wheel, and which will have the characteristics to work harden quickly so that the forces of cavitation will not damage the metal before the hardening takes place.

Figure 26 is a view looking at the suction side of a 42,000 hp 19 ft diameter turbine and shows the typical places on the suction side of the blades that requires

Figure 23 — Close-up view of pitting at periphery of trailing end.

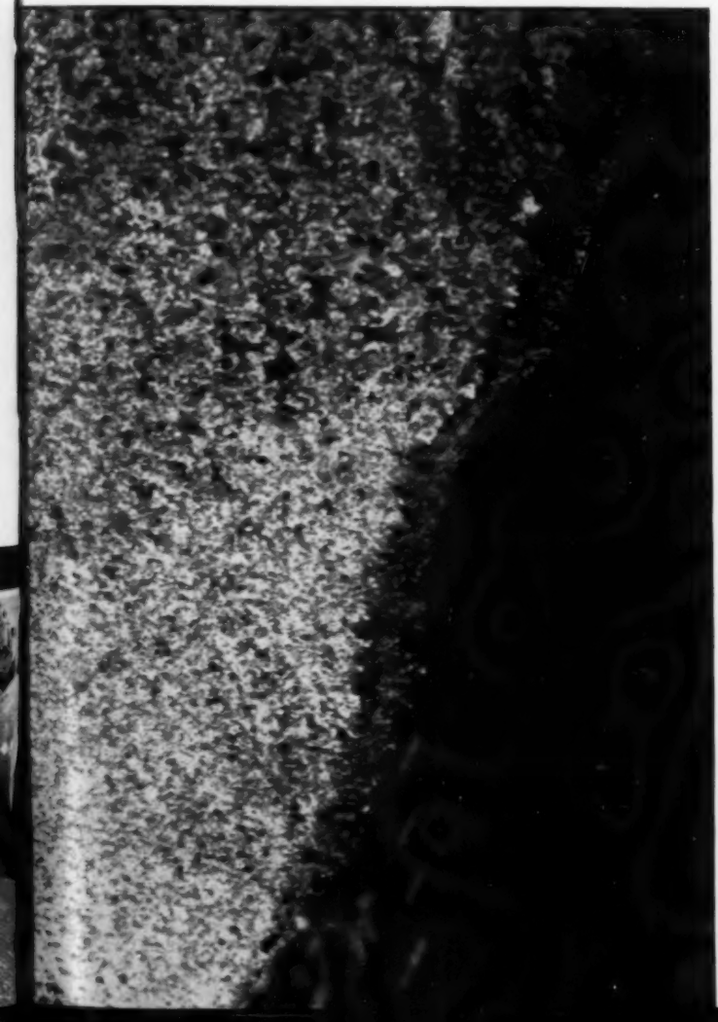


Figure 24 — Serious pitting is shown on the bottom trailing section of a turbine blade.

welding to protect against the forces of cavitation. These locations will vary with each different design, but in general will follow the pattern shown.

Figure 27 represents the repaired area on the suction side of a blade using an inferior quality of stainless steel rod. This rod, even though the analysis was 18 chrome and 8 nickel, did not have the ability to withstand the forces present in cavitation at that location because of the comparatively high carbon content of the welding rod.

It is very important to make sure that the analysis of the rod is known and satisfactory before applying it to the affected areas.

Figure 25 — The trunnion of this blade is pitted and its location makes it difficult to repair.

Figure 26 — Underside of turbine viewed from the draft tube.

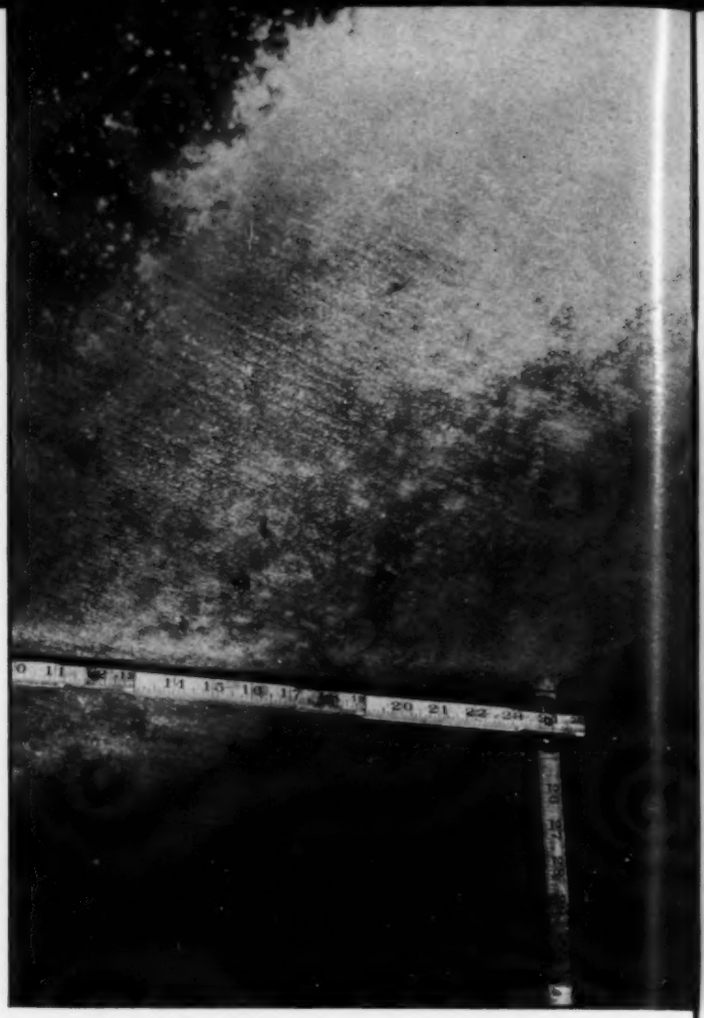


Figure 27 — The underside of this plate was pitted fairly rapidly because the carbon content of the stainless steel rod was too high.

SUMMARY

What has been shown are only a few of our problems, but of these few there are undoubtedly some of them that are experienced also by numerous other users. What have we learned from our experience with these problems? We can summarize them somewhat as follows:

We have learned that we must:

Study all the conditions thoroughly beforehand.

Find out the experience of others. (This can be accomplished best by contact with men in similar industries through membership in committees where uncensored round table discussions are of paramount importance).

Secure advice from reputable manufacturers.

Purchase the best product with the allotted money.

Install or repair under best supervision and under the correct conditions, following recommended procedures.

Not wait too long to inspect or to determine the early condition of the equipment (much can be remedied if caught at an early stage).

Specify and check the materials to be used on a job.

Properly educate the workmen before hand.

Have the surface clean and preferably rough before attempting to protect a ferrous surface against corrosion.

We learned that:

An inhibitor greatly lengthens the life of most organic coatings, thereby protecting the metal.

Hot sprayed zinc does a good job on certain applications and fails badly on others.

Hot sprayed zinc makes a good foundation for a subsequent organic coating.

Under certain conditions dissimilar metals, especially those widely separated in the electro-motive series, should be carefully selected and prevented from creating electrolysis.

Cathodic protection, properly applied is a reliable solution to preventing pitting from electrolysis.

Sharp protrusions and rivets should be avoided in underwater construction involving ferrous metals.

Organic coatings are now being produced that will protect ferrous underwater equipment for many years even under very adverse conditions.

Stainless steels of the proper analysis and properly applied will withstand extremely severe cavitation attack.

Lastly we have learned that no matter how well a product has performed under certain conditions, care must be exercised before extending its use in applications to other almost similar fields, because sometimes

the slightest change greatly alters the serviceability of the product.

It is felt that by our interest in and our studying of the action of metals in service we are now more able to keep metals in service much longer.

DISCUSSION

PRESENTED BY

FRANK N. SPELLER, Corrosion Consultant, 6411 Darlington Road, Pittsburgh, Pennsylvania

G. W. GERHARDT, Senior Fellow, Mellon Institute, Pittsburgh, Pennsylvania

H. A. NELSON, Development Engineering Division, New Jersey Zinc Company of Pennsylvania, Palmerton, Pennsylvania

R. L. RECTENWALD, Chief Engineer, Metalock Repair Service, Inc., Pittsburgh, Pennsylvania

Frank N. Speller: Mr. Hess points out clearly that the price of good metal service is usually good design and adequate protection. The designer, as he says, should consider the maintenance man whose duties should include keeping the metal surface as free as possible from trash and debris of all kinds. For most structures it is of course not economical to use other than ordinary or low alloy steel.

The Safe Harbor Dam has provided a very useful test field for coatings, especially for fresh water service and has materially helped designers and manufacturers in the development of better coating systems. During the war we were worried as to protection that would be sure to keep important underwater equipment in working order in Panama Canal for at least 5 years. The experience at Safe Harbor at that time led us to believe that a sprayed zinc-dust coating 10 mills thick was good for at least 5 years (Mr. Hess reports that it has now given 7 years service), and that a phenolic base tung-linseed oil base paint properly pigmented in 3 coats was good for another 5 years (recent experience shows that alone on a sandblasted surface some of these paints are protecting dam gates in fresh water after 7 years).

The failure of zinc when in contact with a more noble metal, such as the bronze guides mentioned by Mr. Hess, is natural and may be prevented by painting both metals for a foot or so on each side of the line of contact with a good chlorinated rubber or phenolic underwater paint. I suspect that the protection from mud on the lower part of the head gate was also a factor in protecting the sprayed zinc coating. This type of coating has a very porous surface on which river silt would be readily retained.

The protection of parts of turbines subject to cavitation by welding on low carbon 18-8 is a useful and valuable contribution. It is significant that relatively soft stainless steel, which has great capacity for cold work, should be so resistant to cavitation. I believe, this is usually a combination of dynamic impact with some corrosion fatigue.

It would be interesting to know the type of inhibitor which Mr. Hess refers to under item No. 10.

G. W. Gerhardt: I want to comment on Mr. Hess' paper from the standpoint of the application of organic coatings. He made one statement that the fabrication of the article is important from the standpoint of maintenance. It is also very important from the standpoint of initial application. We have found in most cases that those items which are hard to coat initially are also hard to maintain. The type of structure, the riveting, the welding, and the smoothing off of all the rough parts is of vital importance for the maintenance of a good organic coating on the steel.

Secondly, I want to comment on the statement that many coatings or many structures that perform well in one set of circumstances or in one environment, often fail in another set. I understand that the Safe Harbor group have paid particular attention to the preparation of surfaces; in other words, they have been very careful in how they have applied the coatings. It is this point, I believe, that has made their applications serve so well in practice, and it is failure to observe such care that has made a number of other applications of the same materials fail. I believe that application is fundamentally more important than minor changes in environment.

From this standpoint, I might add that essentially the same type of coatings which performed well at Safe Harbor have been used on the emergency gates at Panama Canal that Dr. Speller spoke of, and they have performed very well, giving service on panels at least up to five or six years. Thus it seems that, if the application is correct and, if the right materials are chosen, the structure will perform satisfactorily.

H. A. Nelson: A very important phase of the maintenance problem has been stressed; namely, the advantage of starting with clean (sandblasted) steel, especially when painting surfaces that are to be immersed in water. The value of thorough cleaning of the surface is now quite generally accepted along with the principle that good maintenance requires the contact of an effective inhibitor, whether it be in the form of a priming paint containing inhibiting pigments, such as zinc chromate, red lead or zinc dust, or other preparations, such as phosphate treatments. Both types require a good cleaning job on the steel in order to be effective for underwater service. However, it should be added that the permanence of phosphate washes applied under field conditions is often limited, especially in underwater service, so it is still safer to use an inhibiting primer in the paint system and not depend entirely on the continuity of the paint film to retard corrosion.

Mr. Hess has also suggested the possibility of using sprayed metal coatings as foundations for paint. Although zinc coated steel has been successfully painted for years, the basic idea generally has been that the zinc coating is to carry the corrosion protection load for a period of years, depending on the circumstances, and the use of a metal coating on steel primarily as a base for more or less immediate painting is relatively new. Properly applied, these coatings adhere well and their somewhat rough structure is an asset in that a maximum of mechanical bond of the paint with the surface is attainable along with the adhesion due to the intrinsic adhering qualities of the paint.

It is not assumed that any and all of the current priming paint formulas will be the best for this service. More laboratory development tests and experiments such as Mr. Hess describes will be needed to put the

idea on a practical basis. However, the exigencies of war have already brought about some valuable experience with large fabricated structures which were spray coated with zinc and painted, and then successfully used under submerged conditions in fresh water. This has also been done with spray coated steel barges in service in the Philadelphia harbor with results that are, to date, far superior to that obtained with painted steel alone.

Another procedure developed during the war, which basically involves the same idea, is the application of a relatively thin electrolytic coating of zinc on strip steel, with or without phosphate coating, to serve as a base for painting. This was conceived as a means for conserving zinc metal but the indications are that the idea will survive as a practical means for obtaining a foundation that will serve as a second line of defense for the steel surface and eliminate the rapid appearance of iron corrosion products wherever there happens to be a break or imperfection in the paint system.

R. L. Rectenwald: I would like to ask Mr. Hess if he has had any experience with the use of Type 410 stainless as applied with metal spray equipment. A few years ago on the Monongahela river, at the Morgantown plant of duPont, we had some raw river-water pumps, about 12,000 gpm, and we had the same condition of cavitation, which was also supported by severe corrosion. The acidity of the river water was as low as 4.5 pH. We used a Type 410 stainless spray which was anchored by use of 18-8 studs peened over, so that they had the appearance of mushrooms, and the 410 material was then sprayed on the prepared surfaces. The cavitation and corrosion in this instance had penetrated the 1-in. wall of the cast iron pump casings for an area of about 100 square inches near the end of the Volute Section.

We selected the Type 410 stainless in this case because we preferred the harder sprayed particles which would be about 400 to 500 Brinell, rather than the 18-8 which would be the softer sprayed material. We had a comparative test with 18-8 plate welded in the pump casing, and we noticed a definite indication of cavitation in the 18-8 after a year's operation, whereas the Type 410 did not show any evidence of cavitation.

A similar application was in a 400 or 500 hp Pelton wheel, which we were using to recover power from a high-pressure water scrubbing operation. There we had a sulfurous water and the Pelton wheel runners would run about a year to eight months when complete failure occurred due to cavitation and corrosion.

In this instance we tried all types of stainless sprays, which were not successful, and finally developed a technique of applying synthetic rubber and were able to obtain a bond which could not be stripped from the buckets. This rubber coating was satisfactory after a year's operation and I was not able to get any more data after that because the plant was closed and I left the premises.

The use of synthetic rubber on pressure-reducing valves and the Pelton wheel runners, and sections of pipeline where velocities were very high with very high corrosion rates was satisfactory if properly applied.

I should like to know if your company has conducted any tests of this nature, either with the rubber coatings or with Type 410 material?

P. M. Hess: I did not want to get into this cavitation problem, because we can talk for months on that. We have tried about everything; we have even gone so far as to have one of these 19-ft turbines completely coated with ⅛-in. rubber by one of the rubber companies, and we were afraid we could not get a bond which would hold. However, we did put the raw rubber on the whole turbine, covered the whole thing, and then cured it in hot water for the required length of time. The rubber will not withstand the blows of cavitation that we experience at Safe Harbor. Cavitation chewed it to pieces like a turkish towel.

We also tried many kinds of rubber paints. Each one has a pet name of some kind. They did not stand up. We tried the sprayed metals. They will not stay in place.

It is cheaper for us to weld, because these blades are cast steel, they are not cast iron — therefore it is not necessary to go to all the expense of drilling and putting in studs. There is a company up the river from us that has had success in using sprayed metal of the stainless type, and they use studs also. It is doing very well whereas inserts were not satisfactory for them.

We can chip, weld and grind one square foot per day—one man chipping, one man grinding, and one man welding — and the expense is comparatively little now because the workmen have developed the technique.

We have also found that on the deteriorated stainless steel, which was high in carbon, all we had to do was to weld right over top. It was not necessary to chip the old weld.

We have tried many grades of stainless steels. We know from comparison what we think is best, because we ran accelerated cavitation tests on most kinds of metal. We had many percentages of carbons, numerous kinds of metals in aluminums, bronzes, stellites, and others of that nature, and we think we know pretty well what will stand up best for us. Even plastics have been tried.

The problem is the same with paints. We have permitted every man who comes around to try his pet process. One year there were thirty-three processes tried, and the next year we could not find one even to get a comparison. So as I say, it might work well one place but not at another.

Our turbines have a very high specific speed at Safe Harbor, whereas on a Francis or Pelton unit, the specific speed is lower and consequently the cavitation is less; therefore the blows from cavitation are less severe. There are certain points on the turbine blades where it will tear the metal to pieces in three months; you cannot hold the metal in place unless it is studded and peened over. I will not say it would not hold for us, but it costs us more to stud, spray and grind than it does to weld on a layer ⅛ inch thick. That is all the thickness we need. The rod must be purchased by specification with not over 0.07 per cent carbon. Initially, when we started to weld we could not buy good stainless rods in this country and we therefore used an English rod, which as I said luckily was low in carbon and had ferro-titanium and ferro-manganese flux powder in the asbestos coating, and also a little aluminum wire inside of it. That metal is still perfect, but the cost of the wire was very high. That company went out of business, but by that time America caught up with the stainless game so consequently we have never applied a poor rod in the field.

OPERATION OF INGOT BUGGIES BY REMOTE CONTROL

By K. S. KUKA, Electrical Engineer
Works Engineering (Electrical)
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Jamshedpur, India

. . . . the automatic control system described is simple, and can be easily installed on existing equipment by re-wiring the control panels . . . .

▲ IN many steel mills, ingot transfer buggies operate on some system of remote control, either on the standard magnetic controller system, or the more modern rotating regulator control.

In this paper a system of remote control is described, which is not only remotely operated, but is also automatic, in the sense that the operator can select the furnace to which it is required to send the buggy to receive the ingot.

The advantages claimed for the system are as follows:

1. The operator is stationed at a convenient location from where he can control the buggy as well as other equipment, such as ingot turning and tilting device, mill approach table etc.
2. The furnace pit is selected on a selector controller. The buggy once started, automatically stops in front of the selected furnace pit.
3. As the buggy travels along its path, light signals automatically flash near the operator, indicating the position of the buggy at all times.
4. The number of power rails required including that for automatic signalling is six; i.e. no more than the number required for any other remote control system.
5. The control is self-protected against over-run, as well as accidental grounding of control power rails or control wires, due to dirt and dust, which are common for locations where ingot buggies have to operate.
6. The control equipment required is almost the same as that for the standard magnetic controllers, with either series or compound motors and electric series brakes. The system is simple and easily maintained without any complicated wiring.

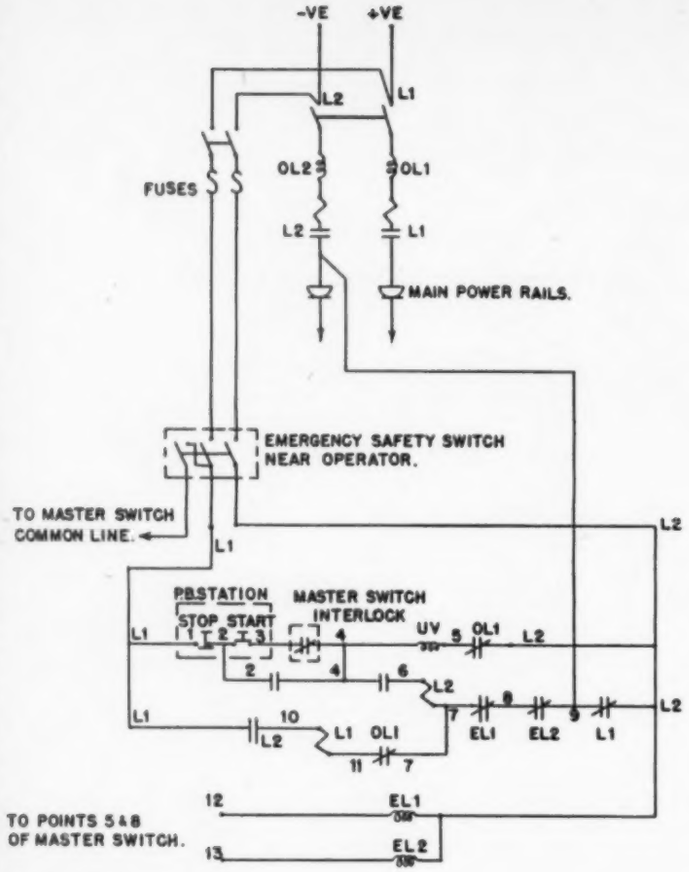
METHOD OF CONNECTIONS

The system of control is shown in Figures 1 to 4. Figure 1 indicates the diagram of connections for the protective panel; Figure 2 gives the connections for the main motor panel. The protective panel is mounted at a convenient location near the operator, whereas the main motor panel is mounted on the buggy itself. Figure 3 shows the diagram of connections for the selector switch to select the furnace pit to which the buggy is required; while Figure 4 gives the connections for remote signalling system.

From the protective panel, power is taken to the main power rails PM1 and PM2. The auxiliary control power rails PC1, PC2 and PC3 carry control power to the main motor panel. PC1 is control power rail for forward direction of the buggy, i.e. toward the mill; PC2 is control power rail for the reverse direction, i.e. away from the mill; the control power rail PC3 is for acceleration of the motor.

The control power rail PC2 is sectionalized at various positions, the sections being so selected that the buggy can stop approximately in front of each furnace. The sections of the control power rail PC2 are connected to the selector switch as shown in Figure 3. The selector switch is an ordinary manual drum controller with notches adjusted as required.

Figure 4 is self-explanatory. As the buggy travels, the collector passes over the various sections, giving circuit to individual lamps, which are numbered according to the furnace pit. As the lamps get lighted in



References

UV—Voltage relay
L1–L2— Main contactors
OL1-OL2 – Overload relays
EL1 — Earth leakage relay for control power rail PC1.
EL2 — Earth leakage relay for control power rail PC2.

Figure 1 — Connection diagram for protective panel.

sequence, indications of the location of the buggy are transmitted to the operator in the pulpit, showing the buggy position at any moment.

PRINCIPLE OF OPERATION

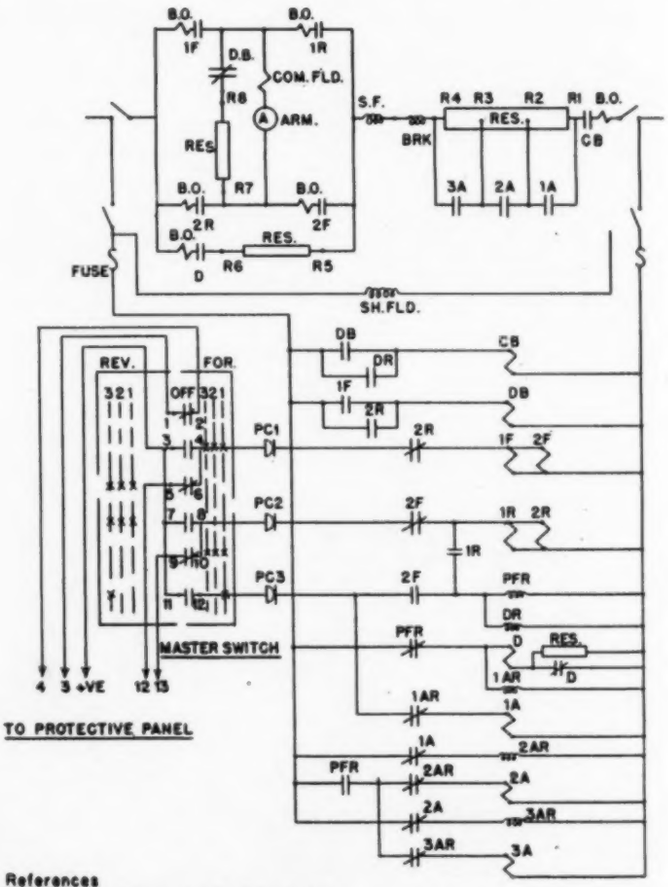
It is required to send the ingot buggy, let us say to No. 7 furnace pit. The operator adjusts the selector switch to the notch for No. 7. This gives the continuity of electrical circuit to control rail PC2 up to No. 6 pit. The protective panel is then energized and the master controller is thrown in the reverse direction. The buggy starts moving slowly and picks up its speed as the main control panel accelerates the motor. The indicating lights keep on showing the position of the buggy as it moves along to its destination. As soon as the buggy crosses over to No. 7 section, the control power is automatically cut off. The directional contactors 1R-2R and the relays PFR and DR thus become de-energized. Contactors 1R-2R and DB drop out instantly; the contactor D, however, gets energized over the normally closed contacts of PFR which also drops out. As the decelerating relay DR is set to drop out after a fixed time delay, the line contactor L remains energized over the closed contacts of DR relay. This forces the motor field, while its armature is shorted over a resistance. The buggy thus tends quickly to slow down due to the dynamic braking action. The DR relay, set to open in 1 second, then drops out, opening the contactor L, which forces the brake to set at once and hold the buggy. The motion is thus brought to a smooth stoppage from its maximum speed. Time adjustment of the relay DR and the adjustment of resistance steps can be selected to meet the requirements of the service according to the location of the furnaces.

During the travel of the buggy towards the mill, the control operates just like a normal controller. If it is desired to automatically slow down the buggy as it nears the mill approach table some distance away from the first roll, the control power rail PC3 can be sectionalized at the position required.

The sequence of operation is therefore as follows:

1. Put on the main switches in the protective panel as well as the main motor panel.
2. Switch on the emergency switch near the operator.

Figure 2 — Wiring diagram for main motor panel.



References

B.O. — Blow-out coil of Contactors.
x — Indicates Master Switch Contacts closed.
Indicates normally open contacts.
Indicates normally closed contacts.
Indicates control power rail.

1F-2F, 1R-2R — Directional Contactors mechanically interlocked.
1AR-2AR, 3AR-DR — Magnetic Time Relays.

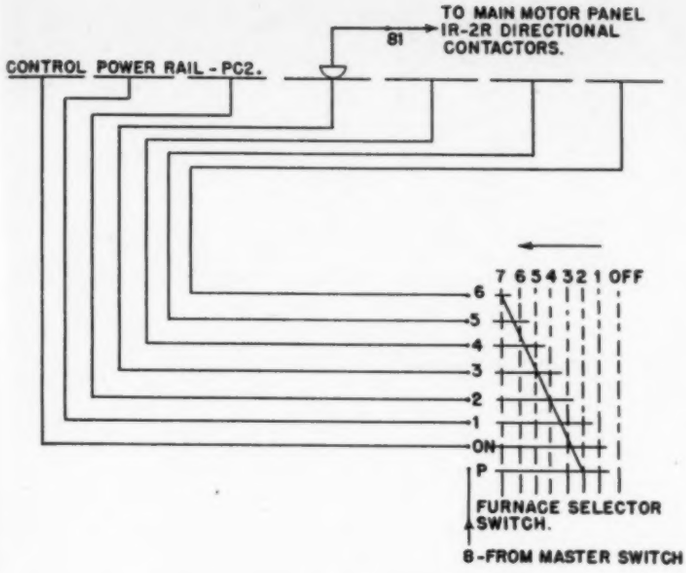


Figure 3 — By means of the selector switch, it is possible to send the buggy to any particular furnace pit.

Control power is then available at the master switch.

3. Set the master switch in the "OFF" position, and press the "START" pushbutton. Protective panel main contactors then go in. The protective panel is so wired that the pushbutton has to be kept pressed until both the contactors L1 and L2 go in. This is a safety provision against accidental pressing of the button.
4. Move the master controller as required and the buggy starts running. First two notches of the master switch give slow motion. The motion towards the mill on the first two notches is intentionally made slower than that away from the mill. The first two master switch notches however, gives the same speed to permit slow movement of the buggy and to prevent inadvertent heavy plugging due to unintentional slight movements of the master switch handle.
5. If the master switch is suddenly brought to "OFF" position from its full speed position, the relay DR allows the buggy to decelerate before the brake is allowed to re-set. This prevents sudden jerky stopping of the buggy.
6. The selector switch selects the proper furnace pit where the buggy is required to be sent. The selector switch is effective only in one direction, i.e. when the buggy is moving away from the mill.

SAFETY FEATURES

The following fundamental safety features are incorporated in the system to get smooth operation under very adverse conditions:

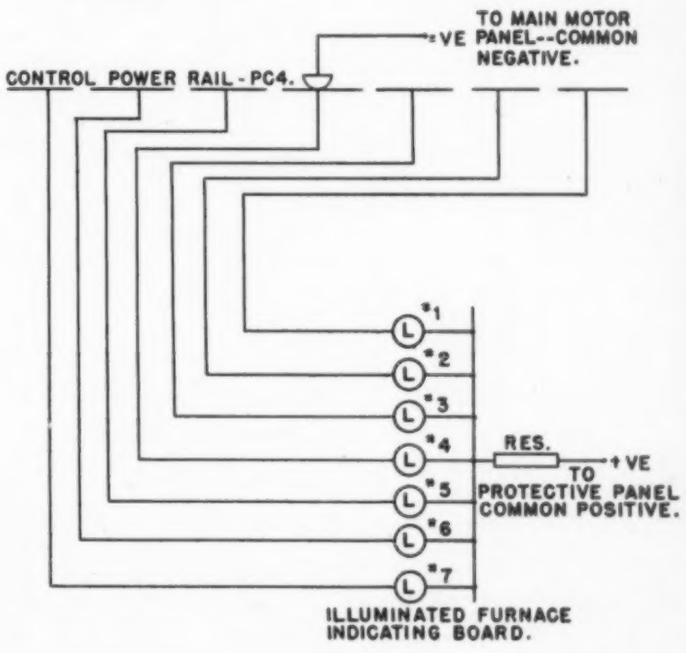
1. It often happens that on a widely spread out d-c network of a steel plant, a ground fault somewhere on the line keeps on hanging due to difficulty of locating it. The troubles start when another pole also develops a ground fault, which may either cause a short circuit or, inadvertently operate magnetic panels. It is therefore necessary to provide protection against sudden starting of the buggy, or the sticking of the contactors due to a possible combination of ground faults on the control lines including the control power rails.

   Voltage relays EL1 and EL2 are provided in the protective panel so connected that if any of the main control power rails PC1 and PC2 develops a ground fault, which tends either to energize the directional contactors even with the master switch in "OFF" position, or that the directional contactors tend to stick when the controller is brought to "OFF" position, the relays become energized at once and disconnect the main contactors L1-L2 of the protective panel. The relays remain energized as long as the fault persists, and makes it impossible for the control to operate. This gives a complete protection against the control system ground faults, which are a great source of troubles and danger in a steel plant.
2. The emergency control switch near the operator can cut off the main control power completely so that the protective panel and the main panel drop out at once.
3. Power rail PC2 is totally disconnected at the last bay so that the buggy cannot go beyond that point as no control power will be available.
4. Further ahead, the main power rails PM1 and PM2 can be broken, so that the main power becomes totally disconnected, if the buggy were to move on still further.

CONCLUSION

The system of control proposed is simple and involves no complications of wiring. Standard control equipment in service can be easily changed over to the new system by re-wiring the control panels.

Figure 4 — This wiring diagram is for the signaling system which indicates the ingot buggy position with respect to furnace location.



LARGE ELECTRONIC DIRECT CU

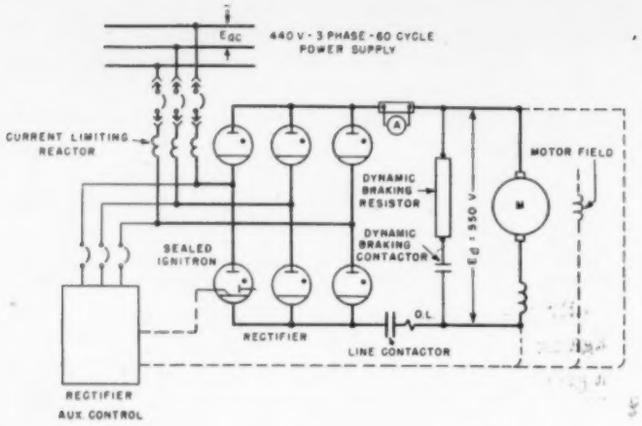


Figure 1 — Elementary diagram of electronic direct-current motor drive.

. . . . developments in rectifying devices and power circuits offer operational and economic advantages for many applications of adjustable voltage electronic d-c motor drives . . . .

▲ DIRECT current motors were the earliest in the field of power equipment, but the invention of the induction motor in 1888, the simplest in construction of any type of electric motor, and the many advantages of alternating current distribution have led to the use of a-c motors for the majority of applications. As three-phase, 60-cycle distribution systems became common, the trend was toward the use of a-c motors on applications which had formerly been supplied with d-c motors. The change to universal use of a-c equipment reached its peak with such inventions as the Cramer and Scherbius adjustable speed drive.

In recent years, however, industry has slowly returned to the use of d-c motors for many applications. It has become apparent that adjustable speed d-c drives are necessary to obtain the high standards of performance required by some modern industrial operations. In locations where d-c power is available, the d-c motor is readily applied, particularly where a limited speed range by field control is sufficient. Motors operating from a direct current power supply inherently possess, according to their type and design, a greater variety of speed torque characteristics and greater ease of control than any other type of motor, but their use is limited because of the prevalence of a-c power.

When an a-c network is the only power supply, some form of a-c to d-c conversion equipment must be used to provide a d-c supply for the motor. The development of efficient ignitron rectifiers has made available electronic adjustable-speed d-c drives. In these drives the motor speed is adjusted by controlling the armature voltage supplied by a phase controlled rectifier and, when needed, an additional speed range is provided by motor field control.

The electronic drive system provides the following features:

1. Wide, stepless speed range.
2. Smooth acceleration by current limit control.
3. Automatic speed regulation at pre-set speed.
4. High efficiency.
5. Rapid retardation by dynamic braking, (when required).
6. Operation from 440 v distribution systems without the use of rectifier transformers.

Single phase rectifiers[1,2,3]* for armature voltage control of d-c motors were first used about ten years ago and found application in sizes from 1 to 15 hp, but this drive has not been of major importance because of its small size and the economic limitations when applied to larger sizes. Recent developments in power circuits and rectifying elements, however, have improved the performance of the rectifier-motor system so that it has promise of becoming one of the most effective drives for motors up to 600 hp.

POWER CIRCUIT

When a-c power is available, a phase controlled sealed ignitron rectifier, operating directly from a 440-volt 3-phase 60-cycle power supply can be used effectively to furnish adjustable voltage to a direct current motor. The double way circuit shown in Figure 1 offers three main advantages when used in the drive system. First, the ratio a-c supply voltage to d-c output voltage is such that a 550-volt motor drive can take power directly from the three-phase supply without the use of a rectifier transformer. This voltage ratio may be expressed as follows:

The average no load d-c voltage, E_{do} is given by:

$$E_{do} = \frac{6\sqrt{6}\,E_s}{2\pi} = 2.34\,E_s$$

and E_s, the rms supply voltage to neutral is:

$$E_s = \frac{E_{do}}{2.34} = 0.428\,E_{do}$$

E_d, the average value of d-c output voltage under load becomes

$$E_d = \frac{E_s}{0.428} - (\text{arc drop} + \text{regulation}).$$

Assuming:

440 volts as the supply voltage,
15 volts arc drop per tube,
13 volts regulation drop

Presented before the AISE Birmingham District Section Meeting, February 24, 1947

* Numbers refer to bibliography at end of this paper.

CURRENT MOTOR DRIVES

By M. M. MORACK
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Schenectady, New York

Then:

$$E_d = \frac{440}{\sqrt{3} \times 0.428} - (2 \times 15 + 13) = 552 \text{ volts.}$$

This rectifier-motor combination provides a simple economical drive when the user's supply is 440 volts, because one of the limitations of this type of conversion equipment has been the economic disadvantage arising from the large amount of equipment involved. The second advantage inherent in this power circuit is that the output wave form is that of a controlled six-phase rectifier which allows the use of 550 volts motors approximating conventional design. It is well known that when d-c motors are operated from a rectifier power supply, the armature current is often highly pulsating resulting in increased motor heating and reduced commutating capacity. The degree of current distortion is minimized by the six-phase wave shape.

When the supply voltage is higher than 440 volts, a three-phase power transformer may be used to supply the drive. Since the transformer windings in this circuit carry current in both directions, the transformer is less expensive than the conventional rectifier transformer which has a lower utility factor and a complicated secondary winding configuration.

EQUIPMENT

The mechanical arrangement of protective equipment, ignitron rectifier, rectifier auxiliary, and motor control units of a typical large electronic motor drive equipment is shown in Figure 2. The a-c switchgear section controls the a-c power supply to the rectifier and protects both the a-c system and the rectifier from a-c overcurrent. A draw-out breaker element is used to disconnect the equipment from the a-c system. The three-phase air-core reactors included in this section are required to protect the sealed ignitrons from excessive fault current. Their rating depends upon the maximum fault current available at the input to the rectifier equipment.

The rectifier section converts the power delivered by the system to d-c at variable voltage and includes the following elements:

1. Sealed ignitrons (tubes).
2. Cooling system (temperature regulating equipment).
3. Excitation equipment.

A typical rectifier assembly is shown in Figure 3.

The rectifier auxiliary and motor control section mounts the rotating regulator control, motor field supply and motor line control. The motor armature circuit (see Figure 1) may include dynamic braking and provides the following functions:

1. Provides overload protection for the motor.
2. Prevents motor from being energized unless cooling water is flowing.
3. Disconnects motor from rectifier in event of loss of field or in event of dynamic braking.

Short circuit protection for the d-c system is provided by the low voltage a-c switchgear. When a group of motors are connected to a single rectifier, overload relays are provided in each armature circuit to trip the a-c breaker.

Sealed ignitrons — Sealed ignitrons[4] in 100-200 and 400 ampere ratings are available for adjustable voltage rectifier service. This family of rectifying elements allows drive ratings up to 600 hp. A cross-section of the 400 ampere rectifying element is shown in Figure 4.

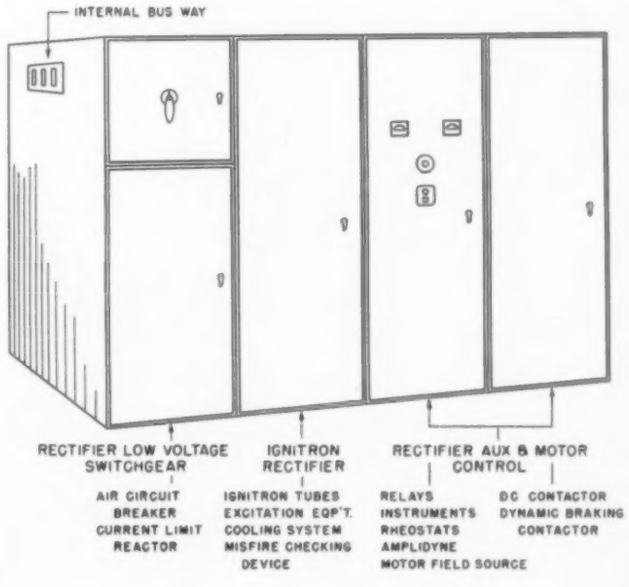
These ignitrons consist of a stainless-steel water jacketed vacuum chamber containing a mercury pool cathode, an auxiliary graphite anode, two ignitor tips, deionization baffles, and a main graphite anode.

The mercury pool cathode is connected to the load circuit through a heavy terminal brazed to the metal envelope. This terminal is also used as a support for mounting the ignitron.

The ignitors are of boron-carbide, which is a refractory material of high specific resistance. One of the two ignitors is a spare. The ignitor creates the cathode spot when it receives an impulse from the excitation equipment.

The auxiliary graphite anode is located above the mercury pool. After the cathode spot has been created by the ignitor, the auxiliary anode functions to maintain the spot for the remainder of the conducting period. This assures sufficient ionization to enable the main

Figure 2 — The arrangement of a typical large electronic motor drive equipment is shown in this figure.



anode to carry the load current, even to a small percentage of its rating.

The main anode, deionizing baffles, and mercury-splash baffles are made of selected graphite. The flexible stranded anode-lead, with its pressed copper terminal is brought out through an insulator of fernico-metal alloy and heavy, heat resisting glass. These latter materials have practically the same co-efficient of expansion over a wide temperature range and their use assures vacuum tight operation. Similarly constructed lead-ins are provided for the auxiliary anode and the ignitors. Resistance welded joints in the stainless-steel envelope, as well as in the "seal-off" contribute to vacuum tightness.

Uniform cooling of all parts of the vacuum chamber is accomplished with water, which is directed upward by helical vanes. This directed flow avoids air pockets or hot spots.

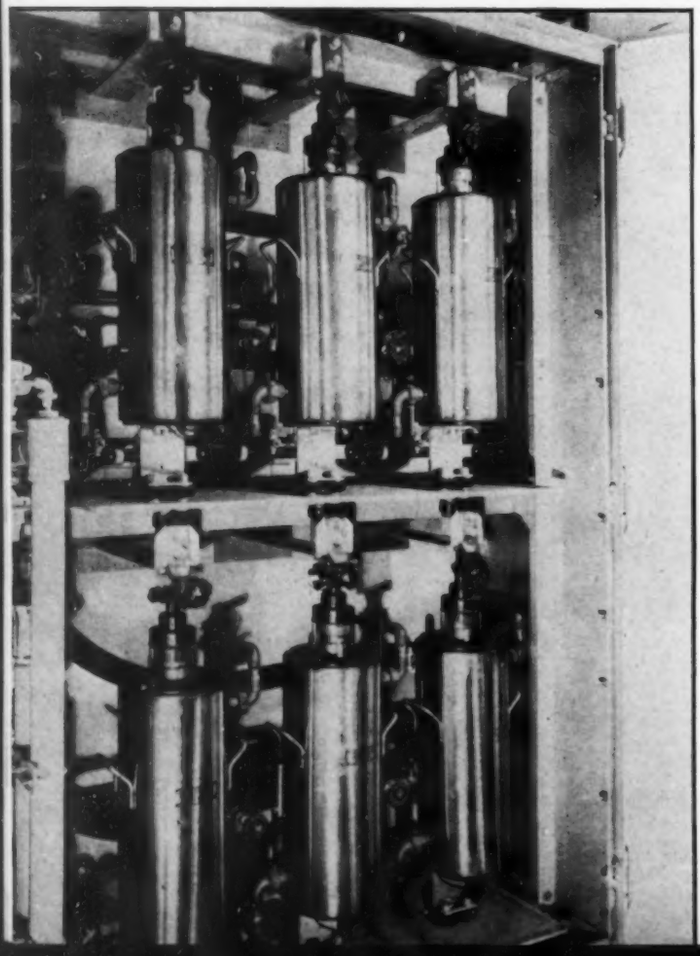
Cooling system — The sealed ignitrons are designed for direct raw water cooling. Tap water suitable for drinking purposes, having a temperature between 10 and 40 C may usually be used.

Water connections between the sealed ignitrons and incoming and outgoing lines are through insulating members, which serve to electrically isolate the sealed ignitrons from the water supply.

An automatic valve is provided in the water inlet which regulates the flow of water to the sealed ignitrons in response to outlet water temperature. A manually operated by-pass valve across the automatic valve establishes the minimum water flow required for safe operation. A water flow relay and water over-temperature thermostat are furnished which trip the a-c breaker in the event of a failure of the water supply or inadequate flow during sustained periods of heavy load.

In applications where tap water is unsatisfactory or where large equipments are involved, water-to-water or water-to-air heat exchangers may be used.

Figure 3 — Shown in this photograph is a typical sealed ignitron rectifier assembly.



Excitation equipment — Each ignitron carries current, in sequence, as its anode voltage becomes positive and the arc is allowed to extinguish at the end of each positive half cycle. Before an ignitron will conduct current, it is necessary to establish the cathode spot or arc. The function of the excitation equipment is to provide the current impulses to the ignitors and thus start the arc in each ignitron at the proper instant and in sequence as required by the supply source. This equipment also provides a means of shifting the instant at which the impulses occur (phase control) and is a convenient means of adjusting or regulating the d-c output voltage from a d-c current signal obtained from an amplidyne control.

The excitation equipment[5], shown in Figure 5 consists entirely of static devices such as reactors, capacitors, resistors, and small transformers. The required peak excitation current is obtained magnetically. The linear reactor (LL) has an air core with an air gap and is designed to give a constant reactance up to rated voltage and frequency of the circuit. A saturating reactor (FL) is built with a closed high permeability core and with a winding such that it will draw a large magnetizing current at the saturation point. The peak of current occurs when the capacitor (FC) is charged to its maximum voltage. The capacitor discharges through the saturating reactor giving an impulse of current in the primary of the transformer (IT). A dry plate rectifier (DPR) prevents reverse current from flowing into the ignitor circuits. An insulating transformer (IT) allows one circuit to supply excitation to two tubes which are 180 degrees out of phase and have different cathode potentials.

The position of the impulses which establish a cathode spot are controlled with respect to the anode voltage by phase shifting the input 3-phase supply to the excitation circuit. This is accomplished by means of a network consisting of fixed and variable impedance reactors (AL) and (PL). The reactor (PL) is a saturable reactor whose a-c reactance is varied by d-c saturation of the magnetic core. The saturating current for controlling the d-c output voltage may be obtained from a control source such as an amplidyne. When the saturating current is at its minimum, the rectifier voltage is at zero. The voltage is raised by increasing the saturating current. In other words, this relationship is identical with that of generator field current and its output voltage.

The phase shifting network also furnishes control voltage to the holding anode transformer (HT) which is supplied with a small a-c voltage to maintain the cathode spot. It may be noted that the auxiliary anode voltage is also phase-shifted by the network.

Rotating regulator control — Figure 6 shows an elementary form of a rotating regulator control used to provide for the control functions of starting, accelerating, and decelerating the drive motor by automatically adjusting the saturating current to the ignitor excita-

tion system. For some special applications, electronic control of the saturating current, instead of rotating regulator control, can be provided. The two types of control are functionally alike.

The amplidyne energizes the d-c windings of the saturable reactors (PL) of the ignitor excitation circuit of Figure 5. As the amplidyne voltage is raised, the saturating current increases, thus increasing the rectifier voltage. By controlling the various amplidyne fields, as will be shown, several control functions are provided:

1. Speed adjustment and regulation.
2. IR drop compensation.
3. Current limit acceleration.

The master speed control element is the tandem potentiometer-rheostat RH_1-RH_2 shown as a hand-operated device, but which may be motor operated if required. The dial (RH_1) controls the rectifier voltage, the dial (RH_2) controls the motor field.

RH_1 is connected, as a potentiometer across the constant potential d-c supply 1-2; it controls the rotating regulator reference and IR compensating field F_1-F_2, connected to raise the rotating regulator (and rectifier) voltage. The voltage control field F_5-F_6 is connected across the armature voltage and opposes the reference field. Thus, by moving RH_1 counter-clockwise, we raise the rectifier voltage.

The starting and acceleration of the d-c motor constitutes a problem in itself when a rectifier is used as a power supply. It must be remembered that when a controlled rectifier is used to furnish the d-c voltage for the motor, neither armature voltage nor current are straight line d-c values. With the motor at standstill the armature current will be limited only by the rectifier voltage and the resistance and inductance of the armature. After the motor has started running, a counter emf is generated in the armature winding, and under steady state conditions represents a constant d-c voltage which may be assumed to be in direct proportion to the speed of the motor. Armature current will flow over a smaller portion of rectified voltage wave and the IR drop will be smaller than with the motor at standstill.

It is a well known fact that the conventional shunt motor operating on a constant voltage source, has a slightly drooping speed-torque characteristic. The speed of the motor will decrease with increasing torque because of the effect of armature voltage drop, which assuming a constant magnetic flux is directly proportional to the torque. The variation in speed is due to armature resistance. At low speeds the percentage of speed regulation is greater since for lower values of armature voltage the IR drop constitutes a higher percentage of the armature voltage.

If the load torque of the motor is increased with a fixed rectifier voltage applied, the armature current and the IR drop will increase and consequently the speed will have to decrease. The average value of armature voltage will also decrease so that speed will fall off rapidly. There are therefore two main reasons for extremely poor speed regulation of a rectifier controlled motor:

1. The armature voltage IR drop.
2. The consequent decrease in armature voltage with increasing torque.

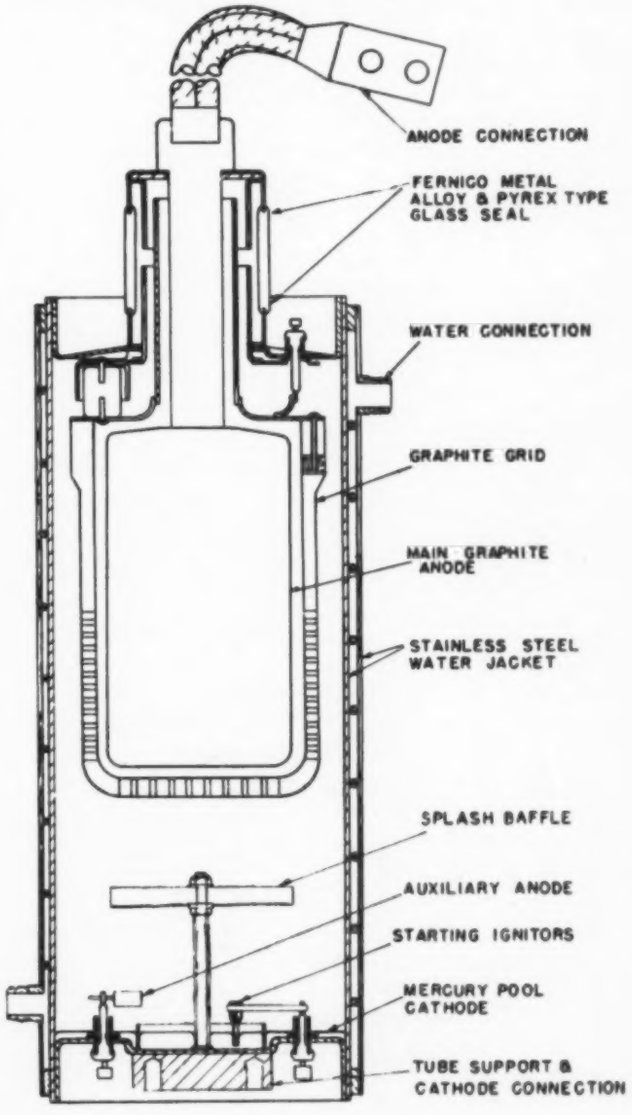
The latter reason is of extreme importance and has a predominant effect upon the characteristics of the rectifier drive.

The speed-torque characteristics can be changed if the angle phase retard of the rectifier is automatically adjusted in accordance with the torque variations, i.e., advanced with increasing torque and delayed with decreasing torque so as to maintain constant speed for any particular setting of the speed control.

To make the motor speed independent of its load, i.e., to make the speed regulation flat at all operating voltages and currents, IR drop compensation is provided. The rotating regulator reference field (F_3-F_4), current is modified by the voltage 3-4 which is proportional to rectifier line current (and motor armature current) and acts to boost the rectifier voltage by an amount necessary to compensate for IR drop in the armature circuit. The constant potential reference sources 1-2 and 5-6 are obtained by rectifying the secondary voltages of the regulating transformer CVT. The primary of this transformer is connected to 440-volt auxiliary control power.

Current limit acceleration is based upon the fact that

Figure 4 — This sketch shows a cross-section of a 400 ampere sealed ignitron rectifying element.



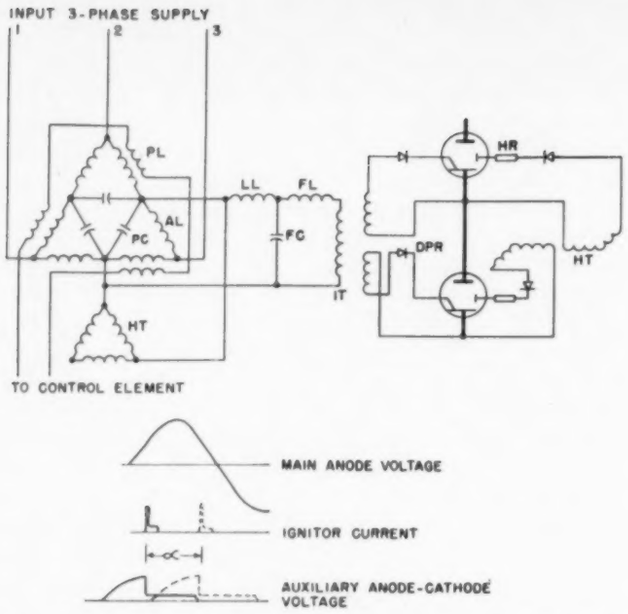


Figure 5 — The magnetic excitation system consists of static devices such as reactors, capacitors, resistors, and small transformers.

control is provided which does not permit armature current to rise above a predetermined value. This method has a definite advantage in that it allows acceleration for various loads depending upon the mechanical inertia of the rotating systems, so that starting will always take place under the most advantageous conditions. Current limit control is provided by the rotating regulator field F_1-F_2. When the voltage across the resistor 3-4 is greater than the drop across the adjustable potentiometer 5-6, i.e. when the motor current exceeds a predetermined value, the field F_1-F_2 lowers the rotating regulator (and rectifier) voltage, preventing any further rise of motor current.

The purpose of the anti-hunt field F_7-F_8, as the name implies, is to stabilize the regulating action of the rotating regulator.

Dynamic braking — When a simple rectifier circuit is employed, the uni-directional conductivity of the rectifying elements prevents regenerated energy from being fed back into the supply system. Regenerative braking is impossible since there can be no reverse current to decelerate the motor. There are, however, many motor applications which require braking. When rapid deceleration is required, a contactor and dynamic braking resistor may be employed.

OPERATION OF ADJUSTABLE VOLTAGE DRIVE SYSTEM

Acceleration of the drive is accomplished by adjusting the output voltage of the rectifier from zero to 100 per cent by phase control. During acceleration to base speed, full field is supplied by the motor by a separate rectifier source. When base speed is attained, the rectifier output voltage is maximum and no additional speed can be obtained by armature voltage control. The motor field may now be weakened to attain maximum speed at full armature voltage. Armature voltage control is used only below base speed because the rectifier supply line power factor varies almost directly as the percentage of voltage reduction. In the upper part of the speed range where the power is required is a considerable portion of the motor rating, field control is desirable because this will give the highest efficiency and power factor.

When the drive is at a standstill and after the control is energized, the motor can be started from rest by the speed control potentiometer rheostat. The drive will move up in speed when the dial (RH_1-RH_2) is turned in the "Fast" direction. Any set position of the dial will allow the drive to run continuously at a particular speed, independent of the load on the motor, provided the load current does not exceed a pre-set current limit. Adjustable limits are provided to manually set the maximum acceleration as desired.

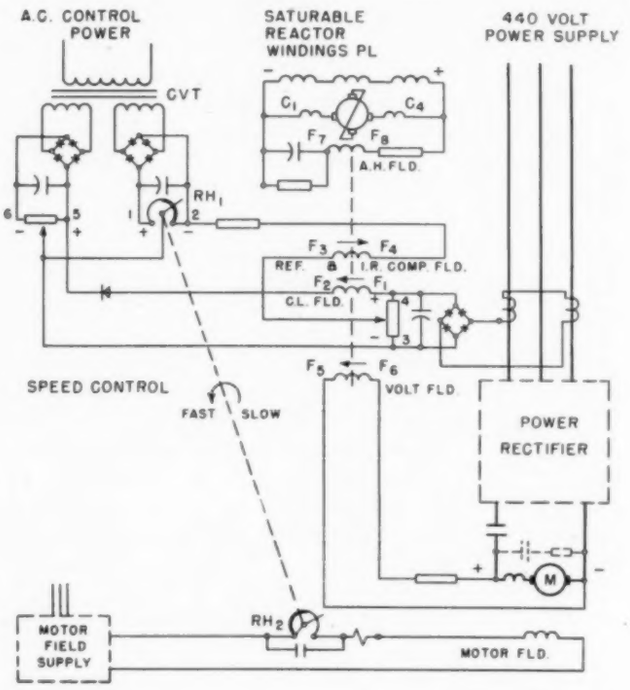


Figure 6 — The rotating regulator system shown provides starting, accelerating, and decelerating of the drive motor.

When running at any speed on the drive motor, the speed can be lowered by turning the speed control rheostat in the "Slow" direction, and allowing the load to lower the speed to the new regulator setting.

Depressing a "Stop" button will stop the drive, taking precedence over all other control functions. When operating at high speed, the normal practice is to reduce the drive speed by means of the speed control potentiometer-rheostat. In the event of an emergency stop, however, depressing an "Emergency Stop" button disconnects the drive motor from the line, and applies dynamic braking.

PERFORMANCE CHARACTERISTICS

The calculated performance characteristics for a typical electronic motor drive are shown in Figure 7. It will be noted that the efficiency is high and reasonably

flat in the running range, but falls off in the low speed range where the power requirements are reduced. The low efficiency at low speeds results from the fact that the major rectifier loss is caused by arc-drop voltage of the rectifying elements which is approximately independent of voltage. When the d-c voltage is reduced by phase retard, the arc drop loss represents an increasing proportion of the total power.

In the upper part of the speed range where the power required is large, some field control is desirable because it will give a better power factor. For some types of load this results in a larger motor than is necessary. On the other hand, if the whole range of motor speed is accomplished by rectifier phase control alone, the power factor of the drive is affected adversely.

When operating under constant field excitation, a d-c motor supplied from a variable voltage source represents a constant-torque of drive and utilizes to the fullest extent its armature volume (D^2L) throughout the speed range. The torque obtainable is limited by the current carrying capacity of the system.

An adjustable speed d-c motor having speed variation by shunt field control represents a constant horsepower type of drive. This drive makes less effective use of its D^2L and its capacity is limited by the voltage of the system and the current carrying ability of the armature. Comparing a constant-torque and a constant-horsepower machine having the same rating at maximum speed, the constant-horsepower motor will be the larger because of the necessity of providing higher torque at base speed. By combining motor field control with rectifier phase control it is usually possible to obtain a drive with the required speed range, while maintaining good efficiency and power factor consistent with first cost.

APPLICATION

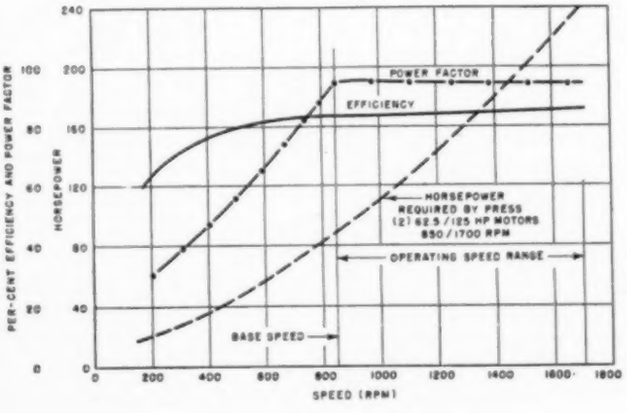
Applications of electronic d-c motor drives using sealed ignitrons are being made in ratings of 100 to 600 hp preferably with 550-volt motors and where reversing is not required. More than a score of applications have been made for printing press drives using controlled rectifiers in ratings between 150 and 300 kw output. Each phase-controlled rectifier supplies power to a group of shaft-connected press motors. The electronic drive provides for complete control functions including starting, jogging, low-speed running, acceleration, and emergency stopping. In this application, that phase control is used only for low-speed operation and the motor field is weakened in the working range to attain wide speed range at good power factor.

An interesting process control application of the electronic d-c motor drive has been made on an induced draft fan in a sludge drier. Flue gases from a main boiler are pulled through a heat exchanger before being discharged into the atmosphere. The secondary air passing through the heat exchanger is recirculated in a closed sludge drying system by a constant-speed fan. The temperature of the secondary air is controlled by varying the amount of hot gases by adjusting the speed of the induced draft fan from 200 to 1100 rpm. The power requirement is approximately 150 hp at 1100 rpm.

Large ignitron rectifiers are also finding application in adjustable voltage systems for main motor drives in steel mills. Notable examples are a drive for 2 continuous tube mills, and an 8-stand reducing mill and a 12-stand mill requiring rectifiers rated 3500 kw and 1500 kw respectively. The rectifiers are designed for 40 per cent voltage reduction by phase control continuously and for 95 per cent reduction for starting.

The equipment is also provided with 50 per cent voltage adjustment by transformer taps for normal operation. Although the rectifiers are capable of operating with large percentages of voltage reduction by phase retard, it is usually more advantageous to provide the voltage reduction for normal operation by extended transformer windings and taps. This follows from the fact that the rectifier power factor is approximately directly proportional to the percentage of voltage reduction by phase retard. For reduced loads or starting conditions, the additional reactive kva is of little consequence because either the magnitude is small or the duration is short.

Figure 7 — The graph shows efficiency and power characteristics for a constant torque-constant hp drive.



CONCLUSIONS

Suitable rectifying devices and power circuits have been developed which permit the use of adjustable voltage electronic d-c motor drives for applications requiring a wide range of horsepower.

Pump evacuated rectifiers in large ratings offer operational and economic advantages as outlined previously, when applied to main drives where rapid acceleration or retardation or reversing is not required. In many fields of application the rectifier motor systems are giving an ease of control and setting standards of performance not attained by older forms of conversion.

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SLAB AND BILLET HEATING SYMPOSIUM

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PNEUMATIC HAND-CHIPPING

By P. S. PALUCH

▲ IN semi-finished surface conditioning there are various processes and operations. Two of the most popular in the steel industry are scarfing and pneumatic hand-chipping.

Before scarfing came into existence, the most common and outstanding means of removing surface defects on semi-finished steel was hand-chipping. For clarification, semi-finished steel referred to here is that which has been rolled on the blooming mills into bloom, billet or slab form and is destined for the hot mills for re-rolling. Up until as late as 1933, practically all defects on semi-finished steel were removed by hand-chipping. Chipping is the ideal of the two, but is too slow a process to keep up with the demand for high production and high quality demanded by modern industry.

First, let us take hand-chipping and discuss it as a process. Prior to 1933, all defects at our plant were removed by hand-chipping. In the bar mill, we had approximately 75 to 80 workmen employed as chippers on each turn. There were three eight-hour turns around the clock. Working this way, of course required approximately 220 to 240 men.

Most all of our steel for our merchant mills, and certain items of slabs were closely gone over by chippers and defects removed accordingly. The balance of the items were hot-rolled without cleaning. Slabs were cleaned by chipping where a special mill edge was required by the customer. The balance of slabs were rolled without chipping, gambling on the yield at the finish end. This caused at times added conditioning at the finish end. These existing conditions caused more stress to be put on the open hearth and soaking pits for a better quality of bloomed steel. Thus, to some extent, when producing certain items, production suffered a setback.

The metal removed through chipping is in turn returned to the open hearth for a scrap price which covers a very small portion of the chipping cost.

A ring valve pneumatic chipping hammer is used which performs at its best with a compressed air pressure of from 95 to 100 psi. A trigger within the grip handle controls the staccato rapid fire inner mechanism. There are various size hammers for chipping. The bore on most all of these hammers is 1⅛ in. in size. The strokes vary from ¾ to 4 in., depending on the service desired. The most popular hammer for chipping at our plant has a 1⅛ in. bore with a ¾ in. bushing inserted. It operates on a 2 in. stroke basis. Its over all length is 13¼ in. It operates at approximately 2400 blows per minute when new. Added wear and temperature changes tend to decrease the blows per minute. The length of the stroke on the various type hammers determines the blows per minute. A ¼ in. hose attachment is sufficient.

The cutting tool or chisel is not a part of the pneumatic hammer. It is inserted into a ¾ in. bushing at the mouth of the hammer. These bushings are removable and can be changed when worn. A worn bushing oftentimes causes accidents resulting in smashed hands. This is only due to carelessness and neglect on the operator's part in not checking his equipment. The worn bushing causes added stress and friction on the neck of the chisel causing a break at this spot. The average speed of an air hammer chipping at a depth of ⅛ of an inch is 14½ inches per minute, and at a depth of 1/16 of an inch, 28 inches per minute. The above figures are based on the softer grade of forging steel. High carbon and alloy steels greatly decrease this speed. The size of man for actual operation of hammer can be average, but for durability a larger man is best. He can lean his weight against the hammer, where his smaller co-worker will have to apply physical exertion to achieve the same result.

The cutting tool or chisel used has an insert neck of a few points under ¾ in. in diameter. This neck is approximately 2 inches in length adjoining the balance of the chisel proper. Overall length when new is 8 to 9 inches. The chisel is made from ¾ in. hexagon stock. We have found through experience the most desirable steel for this tool to be of the following analysis: C 0.44, Mn 0.77, P 0.013, S 0.019, Si 3.18, Cr 0.30, Mo 0.030, Ni 0.050, Vanadium 0.17 per cent. Other high tensile and alloy steels have been tried, but we have found the aforementioned to be the most rugged and durable on any type of steel chipping.

The cutting end of the tool is tapered down by forging

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to a shape where the top side of the cutting end is flat and the bottom side is slightly rounded. The extreme point of the arc formed by this rounded bottom is approximately 1/8 in. deeper than the line formed across the terminals of the arc at the edges. The cutting end usually is one inch in width. The curvature of the bottom side allows the tool to be indented into the surface of the steel. The depth, of course, here is dependent on the operator's judgment. By the curved bottom effect of the tool he can proceed if he cares to down the full length of the bar, provided condition requires him to do so. A chip removed is as thick as the depth of the cut removed, contoured to pin point thickness at the edges. Thus each chip removed has knife-like edges. The depth of each cut always governs the width. That is to say, the deeper the cut the wider the cut. Deep defects are always flared to provide a proper contour for rolling. This ratio is usually about 1 to 10 or 12.

The material to be chipped is placed and removed by overhead double or single trolley magnet cranes, depending on the size of the material. All chips are removed in the same manner. The steel is placed on skids of 10 in. high. This allows each operator to get better traction with his feet. Chippers take out what defects they personally see and then are re-checked upon by inspectors for approval. Defects removed are scabs, slivers, deep and light seams, etc.

Chipping has been found to be the best for removing defects on the smaller bars of 2½ inches or under. Also we have depended a great deal on chipping for steels of high alloy quality such as armor-plate, high carbon N.A.X., and chrome-nickel steels that cool down below the 500 F temperature. The 500 F temperature or over is the requirement on these items for hand scarfing. Scarfing these items below this point causes checking. During the war years a great deal of alloy steel which required cleaning, cooled beyond the 500 degree requirement before the scarfers could get to it. An overloading demand for these types of steel brought this about. Here the chippers with their pneumatic equipment came in very handy.

Protective equipment worn includes goggles, safety shoes and leather gloves. Most chippers wear leggings or wrap their legs with other protective clothing to protect their legs from the knife-like edges of the chips.

APPLICATION OF HAND SCARFING TO MODERN SURFACE CONDITIONING

By P. S. PALUCH

Scientists, late in the eighteenth century, discovered the substance called oxygen. Oxygen is the most important of 92 elements. It makes up 47 per cent of the earth's crust, one-fifth of the atmosphere, and eight-ninths of water. Oxygen can be joined with many other substances to make compounds. When union with another substance is slow it is called oxidation, as in the rusting of iron; when it is rapid and accompanied by light it is called combustion. In 1836 Edmund Davy, a professor in chemistry, discovered when a black substance known as potassium carbide is brought into contact with water, it creates a colorless gas called acetylene. This gas, it was found, when combined with pure oxygen could create a temperature upwards of 6300 degrees Fahrenheit. Time brought about torch inventions to combine the two substances for combustive purposes. As a result the oxyacetylene torch came into existence. This torch for numerous years was used exclusively for metal cutting. Approximately a decade and a half ago, this metal cutting practice was applied to the removal of metal surface which to this day is known as scarfing. The term "scarfing" is probably derived from the word "scarify," meaning to burrow, cut or scratch the surface or skin.

Scarfing at our plant was first given consideration for trial in 1933. At this time, it was introduced as a cheaper, faster and more thorough method of removing surface defects on all types of steel. Management decided to give it a trial on forging blooms of 7 × 7 and 6 × 6 in. size.

As all new discoveries and methods have their preliminary troubles and faults which must be ironed out, this was no exception. When we look over present day scarfing equipment and methods of procedure, compared to what was known at first, it is evident that there were more wrinkles to be ironed out, than was realized at that time.

To begin with, the instructors sent with the trial equipment, knew all there was to know about oxygen, acetylene gas, repairing of equipment and adjustment of the same. But, in actual teaching of the work, they knew only the purpose and theory of the operation, and were not too well gifted in applying them. The instructors, as time went on, learned as the students did, through actual practice.

The first torch brought in was 36 in. in overall length, and No. 24 tip was inserted at the cutting end. This tip set at an angle of approximately 110 degrees. The purpose in this angle is to give the operator the proper cutting slant for each cut and also keep the hot sparks blowing away from the operator as much as possible. This torch had three copper tubes leading to the head, one for acetylene, one for oxygen to mix with acetylene for proper preheat, and the other for high pressure oxygen alone. This No. 24 tip had a 7/32 in. opening and 6 No. 54 preheat holes. The scarfers set up their own equipment. The acetylene was connected with 3 tanks joined together with one manifold and to which the gas lead hose was attached. Oxygen tanks were joined together, five to a manifold, with an oxygen lead hose attached. These hose were in turn attached to the torch. The amount of flow pressure of each product was regulated by gages. At that time the pressures were 75 psi on the oxygen and 12 psi on the acetylene. The process performed was the removal of all surface defects on blooms by skinning, that is, the removal of all original surface. In ordinary cutting of metal by torches the metal is heated by the burning mixture of acetylene and oxygen emerging from the preheat jets. This mixture can produce a temperature as high as 6300 F. (Hereafter when the word pre-heat is used it will refer to this burning mixture.)

Early scarfing was performed by pre-heating a spot

just ahead of the area to be removed. At the split second that a melting point was reached at this spot, perfect timing of three actions were required and still are for good scarfing. First, the tip is set on the preheating spot vertically at approximately a 65 degree angle. At the split-second that the melting point is first realized, the following three things must be performed simultaneously in one action:

1. High pressure trigger is pressed.
2. Tip is tilted back from 60 degree angle vertically to approximately a 30 degree angle vertically and 10 to 15 degrees laterally.
3. Torch is moved in direction desired.

Lateness in starting to tilt tip at pressure of trigger would cause splashing instead of the cutting action wanted.

At the same time a late get-away at the pressure of the high pressure handle blows a hole at the start of the cut. This timing was then very hard for a majority of workers to acquire. Therefore a great deal of steel was rolled with many poor starts or small holes.

The following will explain by an example what happens during the course of a cut after the start.

Most everyone has at sometime or other picked up a water hose to wash off a sidewalk. As an example let us take a sidewalk with a great deal of dirt. Now in moving your stream straight forward up the sidewalk, vertically at 30 degrees and walking straight ahead, the force of the water caused the dirt in its path to splash forward and to both sides. However, had you walked straight up the sidewalk with your stream angled laterally toward one of the sides, the dirt would all splash to one side and forward. The other edge of your path of the stream would be the portion untouched by the stream with very little or no splash, and the splash would all be to one side. Upon your return you would start your stream again at the same angles along the splashed edge and that would force your dirt and splashing to one side, leaving the opposite side clean. Scarfing the surface on a piece of steel is done on the same principle. In taking a cut the torch is angled so that all the metal flows forward and to one side. The metal flowing to this one side does not entirely deoxidize into scale. The unoxidized portion is an overlapped metal waste adjoining the cut. This in scarfing is called "fin." In taking the next cut this fin is removed with the cut. Of course each succeeding cut has its leaving of fin. After the last cut is taken, light cutting pressure with this torch removes this fin. In the end you have left the opposite sides of the cuts from which the flow was diverted. Each cut, as in chipping, is contour in shape.

Going back to where we discussed the method of operation of the torch, the scarfers were taught to scarf in reverse to present day practice. The flow of burning metal and sparks were toward the operator's side of the cut and each adjoining cut was taken on the operator's side of the previous cut. For a man to learn the job this way it required months to be able to place his adjoining cuts next to each other. The secret was that the edge of the cut to be followed was visible within the flare of the burning metal. Only a very experienced eye could detect this edge within the flare. Otherwise you could start at a particular part of the surface and end up at an unexpected destination. A good analogy is to go looking for something in a dark room with a lighted candle directly in front of one's eyes? Nothing can be seen until such time as the light is reflected against some wall or object. If one takes a pair of burning goggles and starts down the surface of a slab with a scarfing torch, there will be the same reaction. On very scabby or seamy surface, even the most experienced scarfers had difficulty in following their cuts by this method, due to the disturbance within the flare. Experience and time changed the method of scarfing. A scarfer today takes a cut with his tip angled in such a way that the flow of burning metal and sparks are in the direction opposite of himself. In this way the guide for his succeeding cut is the reflection of his flare in the preceding cut. This has cut the time of apprenticeship practically in half.

Blooms at that time were scarfed on skid beds, 16 in. high, in groups of 4 pieces together. They were provided by an overhead magnet crane. After each side was skinned, remaining defects were removed by spot scarfing. These blooms were turned over with long handled wrenches by the scarfers themselves. After completion, they were removed by overhead crane. Later in 1934 a conveyor line, 2 ft wide with roller bearing rolls was constructed. This was a hand conveyed affair with a capacity of 8 blooms end to end, an ideal setup for blooms with surface defects of average depth, but a very bad setup where defects ran deep. A few pieces of this sort created a bottleneck. The blooms were skinned on this line and then pushed off onto an inspection bench for removal of remaining defects by spot scarfing.

In 1936 Wm. Morris, then bloom, bar and hot strip superintendent, decided to give scarfing a trial at slab

TABLE I

Torch Type C-51 (Automatic rod feed)
Oxygen pressure at torch entrance — 50 psi
Size of cutting orifice — 3/8 in.
Preheat holes — 8 holes, No. 55 drill (0.052 in.)

	N.A.X.	Rim
Dimensions of slab area covered, in.	(34 x 179)	(37¼ x 156)
Angles of cutting:		
Vertical	40°	40°
Lateral	15°	15°
Number of cuts required to skin area	23½	27
Average width of cuts, in.	1.47	1.37
Lineal feet covered	350.62	351
Lineal feet per trigger minute	29.7	33.1
Sq ft covered	42.89	42.65
Sq ft per trigger minute	3.63	4.0
Average depth of stock removed, in.	0.0457	0.043
Total oxygen used, cu ft	359.5	322.48
Cu ft oxygen per sq ft	8.38	7.56
Cu ft oxygen per lineal ft	0.975	0.92
Total weight removed, lb (one side)	80	75
Pounds removed per cu ft of oxygen	0.222	0.233
Total trigger time, seconds (one side)	11.81	10.59
Total torch time, seconds (one side)	15.27	14.04

conditioning. The scarfers realizing a chance to acquire more work and steadier employment did their very best to win Mr. Morris' confidence in scarfing. To this very day we are scarfing the major portion of slabs bloomed.

In 1937, the fact that the flow of metal from one piece could be transferred to ignite the burning of an adjacent piece and keep on cutting, brought about the invention of the starting-rod feeder. This one thing did more to boost the value and expansion of scarfing than any other feature known.

It was this starting rod which first convinced management that scarfing was a coming thing. It was in this same year that a small C-32 torch of approximately 26 in. in length was introduced for scarfing of defects from bars and billets in sizes of 4 × 4 in. and under. It was on this steel that chippers were used exclusively. Deep starts could not be gambled upon on these items. This torch with its starting-rod feeder was just what was required.

To discuss the starting rod and its principle, the operating mechanism is enclosed in an aluminum cast case, designed for minimum of weight, ½ inch thick by 1½ inches wide. Its overall length is dependent on the length of tip used. It is located as close to the head of the tip as possible. This case guides the starting rod to cross the middle of the mouth of the tip and to set at ¼ in. off the end of the tip. The starting rod is entered into a small entrance guide hole in the edge of the case, passes through the case and comes out through another guide hole on the opposite edge of the case; from there leading to the mouth of the tip. Within the case the rod fits through a small movable block with bore slightly over the thickness of the starting rod. This block is pulled in the desired direction by a lever which in turn is pulled by a cable adjoining a trigger at the operator's end of the torch. A pull on the trigger causes the small block to be pulled forward, and the off-center pull on this block causes the rod to be pulled forward by the tension of the bore against the rod. This block is returned to its original position by a spring. The rod itself is of 3/16 in. low carbon steel. From ¼ to ⅜ in. of rod is placed in front of the mouth of the tip with each pull of the trigger and meets the sudden temperature of the pre-heat. At melting point, the cutting pressure applied transmits this combustive action to the surface proper and this melting point is kept up for the duration of the cutting. Here again perfect timing can make the difference between starts of practically nothing and starts of damaging depth. A scarfer with perfect timing can get his cuts to be as shallow at the start as at the terminal.

With this starting rod attachment, the hand chippers faded out of the picture within a very short time, and were made available for other work. It was not long before a larger torch, already mentioned, was equipped with the same apparatus. By 1938 practically all cleaning of steel was done with scarfing.

In 1938 the 46 in. blooming mill started up. Here at this time an extension of 8 in. was made on all C-18 torches, making them 44 in. in length and convenient for scarfing slabs of 44 in. wide and over. There has been a definite improvement in construction of torches and methods of operation. All tips were also equipped with a changeable stellite ring for longer wear.

From recent tests conducted with the various types of torches at our disposal, the data of Tables I, II, and III were compiled. Here each torch is shown as to its effectiveness on two different grades of steel. Fine grain alloy slabs of 0.09 per cent carbon hi-tensile strength used here will be called "N.A.X." Also straight carbon slabs of 0.06 per cent carbon used here will be referred to as "Rim."

TABLE II

Torch Type C-18 (Hand operated rod feed)
Oxygen pressure at torch entrance — 60 psi
Size of cutting orifice — 9/32 in.
Preheat holes — 8 holes, No. 63 drill (0.037 in.)

	N.A.X.	Rim
Dimensions of slab area covered, in.	(43 x 152)	(37½ x 159½)
Angles of cutting action:		
Vertical	40°	40°
Lateral	10°	15°
Number of cuts required to skin area	38	31
Average width of cuts, in.	1.13	1.21
Lineal ft covered	483	412
Lineal ft per trigger minute	25.9	26.8
Sq ft covered	45.39	41.53
Sq ft per trigger minute	2.4	2.7
Average depth of stock removed, in.	0.054	0.035
Total cu ft of oxygen used	591.02	487.03
Cu ft oxygen per sq ft	13.02	11.73
Cu ft oxygen per lineal ft	1.22	1.18
Total weight removed, lb (one side)	100	60
Pounds removed per cu ft of oxygen	0.169	0.123
Total trigger time, seconds (one side)	18.63	15.37
Total torch time, seconds (one side)	24.45	19.85

TABLE III

Torch Type C-59 (Automatic rod feed)
Oxygen pressure at torch entrance — 34 psi
Size of cutting orifice — 5/8 in.
Preheat holes — 12, No. 59 drill (0.041 in.)

	N.A.X.	Rim
Dimensions of slab area covered, in.	(43 x 150½)	(37¼ x 156)
Angles of cutting:		
Vertical	40°	40°
Lateral	15°	15°
Number of cuts required to skin area	18	16
Average width of cuts, in.	2.38	2.34
Lineal ft covered	225	208
Lineal ft per trigger minute	35.5	31.1
Sq ft covered	44.94	43.23
Sq ft per trigger minute	7.1	6.5
Average depth of stock removed, in.	0.057	0.071
Total oxygen used, cu ft	638.30	669.64
Cu ft oxygen per sq ft	14.20	15.49
Cu ft oxygen per lineal ft	2.8	3.2
Total weight removed, lb (one side)	125	105
Pounds removed per cu ft of oxygen	0.164	0.187
Total trigger time, seconds (one side)	6.33	6.68
Total torch time, seconds (one side)	10.55	9.55

Seams, scabs, and slivers of light depth were removed in the tests, illustrated by the tables. These tests give an idea of the various capabilities of scarfing compared by torches and the orifice therein. These must not be construed as standard measurements, due to too many factors having to be considered.

The variables which may cause any or all of the recorded figures to change may be any one or all of the following:

1. Conditions of surface vary greatly.
2. Skill of various operators vary.
3. Angles of tip at cutting can vary.
4. Analysis of steel varies.

Some of the other points proven by the tests are:

1. The 3/8 in. orifice is the most efficient and economical on the basis of metal removed per cu ft of oxygen and its speed per trigger minute.
2. The lateral angle undoubtedly determines the width of the cut.
3. Greater speeds can be achieved on fine grain steel than on Rim steel where the cutting is of equal depth. The slower fusion of the softer steel often causes deeper cutting and thereby decreases speed.
4. The larger orifice decreases the pressure at the torch opening although the line pressure ahead of it is much greater.
5. Another proven fact not shown in the figures but true, is that some operators in trying to achieve a very wide cut, lateral their cutting angle too much. By doing this the speed is cut, the cut is widened, a great deal of oxygen escapes fusion and is wasted, and also a damaging ridge is caused on the side of the cut from which the flow was diverted. This ridge in rolling will overlap into a sliver.

To get away from the torches, let us check the source of fuel. As related in the beginning, tanks of oxygen and acetylene were hooked up to manifolds in groups of 5 and 3 by the scarfers themselves. Present consumption of these fuels with the expansion of scarfing has brought about installation of plants to furnish each. Acetylene is supplied by carbide generators. A charge of 500 lb fills each generator and each pound of carbide produces approximately 4½ cu ft of acetylene. These are operated and maintained by the pipe shop. The oxygen plant is manned by the supplier. Oxygen is brought in liquid form to this plant. Three in. pipe mains carry the loads to the various docks where master gages control the pressure to the branch outlets at each dock. Back-flash tanks on the outlets and at the main, guard against backfiring into the main line. The scarfing equipment, torches, gages and hoses, etc. are maintained by the welding shop. Hoses, 3/8 inch in diameter, are standard conductors of the fuels. The only exception is a ½ inch hose which carries the extra load necessary for the C-59 torch with its 5/8 in. orifice.

At the Great Lakes Steel Corporation we have two scarfing docks for handling of slabs of lengths of 16 ft and under. These docks have cement bases, 36 ft in width, and are 175 and 132 ft in length. The docks are equally spaced off into working and stock piling sections. Working sections are comprised of 4 blooms, 8 inches square and 36 ft long. These lie across the width of the dock, evenly spaced at approximately 52 inches. This facilitates handling of both long and short slabs. The piling or stock sections are combinations of two pairs of these 8 × 8 in. blooms placed 2 in height for an elevation of 16 inches, and set apart to accommodate whatever length lifts are to be serviced. These are moved closer together or outward by the gantry crane as necessary. The slabs are brought to the scarfing dock in counterbalanced three legged loading beams called spiders, by overhead cranes in lifts of 6, 7 or less depending on the thickness of the slabs. They are placed across these stock skids. From here they are conveyed to the various work sections by double magnets attached to a gear driven ram controlled by the trolley of a 5-ton capacity gantry crane of 40 ft span.

On these work skids the visible defects are marked with crayon. The scarfer then removes the defects with his torch. During the course of scarfing he sometimes runs into defects under the surface which cannot be detected with the naked eye, and these are removed accordingly. All defects are visible within the cutting action. Edge defects are removed to a depth of 3/16 in. Anything deeper is allowed to remain to insure maximum uniformity of width and avoid possible damage to mill verticals. The slabs are then turned over on these work skids by the gantry crane and the same procedure is repeated to complete the slabs. They in turn are then re-piled on a piling skid and removed by the overhead crane. On the gantry crane, the double magnets are affixed to the ram to remain parallel at all times to the length of the dock. There is no swing to bother with as in cable cranes, making the crane far easier to operate and allowing a great many more slabs to be handled.

In scarfing of slabs and smaller billets for the merchant mill, a much simpler method is used. Here the material handled is all 23 to 30 ft in length and varying in sizes from 2½ × 14 to 2½ in. squares. Cranes of 15-ton capacity place the material across cast iron skid beds, 15 inches high and 54 ft in length. For balanced distribution of weight, the span between these skids is from 17 to 18 ft. Here bars are used to spread lifts of slabs apart for edge and surface inspection. Lifts are spaced apart to allow safe and adequate passage in performance of the scarfing. Wrenches are used to turn over material. Scabs, slivers, breaks, seams, etc., are marked with crayon, removed with the scarfing torch and re-inspected for thoroughness. On smaller 2½ in. squares, an oxygen blow pipe pressure of 60 psi is most desirable. This reduced pressure lessens the amount of heat applied and the lessened speed of flow reduces the amount of splash to practically nothing which results in little or no fin. After scarfing the material is removed and placed in racks to await rolling.

Straight carbon steels where the manganese content is below 1.35 per cent and carbon not over 0.45 per cent can readily be scarfed at atmospheric temperature.

Alloy steels of 0.20 carbon or less, regardless of other contents, can also be scarfed at atmospheric temperatures.

Carbon steels of over 0.45 carbon per cent, also manganese hardened steels, and alloys bearing chromium, zirconium, nickel and high silicon content have very little self quenching stability and must be treated accordingly. The fine grain structure cannot withstand the rapid expansion caused by the sudden heat applied. This results into checking or cracking. To avoid this these items have to be worked at a temperature of 300 to 500 F. Scarfing at temperatures of over 500 F causes

the oxidized scale to adhere solidly to the surface, making it difficult to remove. Therefore working at this temperature you have the most efficient medium for meeting the exception created by this steel to cold scarfing.

The scarfing torch has spared many a slab from being returned to the open hearth as scrap. Open hearth production has increased with the addition of scarfing, although certain specific items get special attention, where the required tolerance requirement of the customer is close.

Scarfing now conditions the major portion of all bloomed steel with approximately one third the manpower required previously for chipping bars only. Scarfing has greatly helped reduce rejections at the finish ends thereby increasing shipments. Scarfing served a great purpose during the war, and is continuing to be a great help during peace time.

BILLET CONDITIONING WITH MECHANICAL CHIPPERS

By J. H. VOLLMER

Conditioning of semi-finished steel products is an operation that has become recognized as vitally important in the production of quality steels.

In the more recent years the growing demands for higher standards, and more exacting surface quality requirements of the finished product, has increased the necessity of conditioning to a point, that today the major portion of semi-finished steel requires some conditioning before re-rolling into a finished product.

This trend to more exacting requirements, has multiplied conditioning problems, making it imperative from the viewpoint of quality and economy, that the method of conditioning be applied that is best suited to the product to be conditioned.

In tracing the evolution of billet conditioning, it will

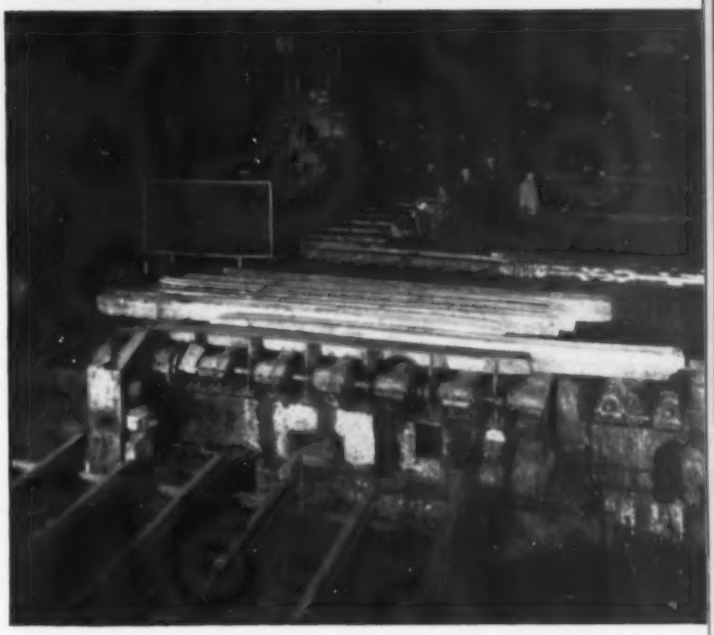


Figure 2 — The feed table is loaded with billets prior to conditioning. Billets are fed one at a time from the feed table to the feed rolls in about 15 seconds. The billet is being conveyed over a series of driven feed rolls toward the machine, and travels approximately 96 feet per minute on all table rolls.

Figure 1 — A general view of a mechanical chipping unit, with the feed table at the left, the chipping machine in the center, and the runoff table at the extreme right. The operator is shown at the pushbutton controls, and from this central point all eleven motors, necessary to the operation of the machine and tables, are controlled.

Figure 3 — The billet is now clamped by the chucks and up against the stop ready for chipping. The chucks are actuated by an air cylinder and controlled by a conveniently located hand lever air valve.

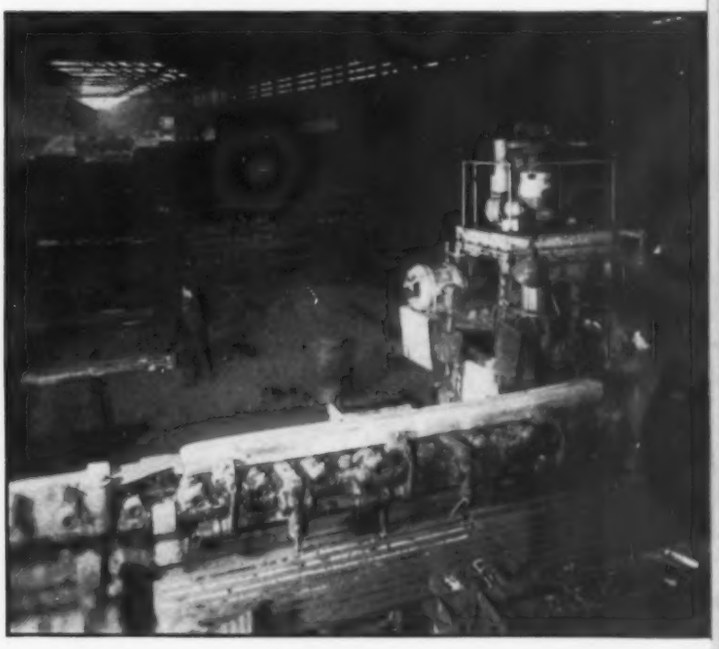


Figure 4 — A 9-tool cutting head is shown in operation. The speed of the cutting head can be adjusted to different types of steel. With a range of from 5 to 10 rpm, a 9-tool head makes 45 to 90 cuts per minute; this can be reduced on hard steel or deep chipping, by using an 8-tool head with 40 to 80 cuts per minute, or increased on soft steel or shallow cutting, by using a 10-tool head with 50 to 100 cuts per minute. The tools are held in place by a wedge clamp which allows a quick change in case of breakage. The head travels forward in the cutting direction while rotating at 150 inches per minute, and the reverse or idle speed is double that or 300 inches per minute. The up and down travel of the head in the elevator cage is approximately 16 in. per minute; however, with 60 to 80 starts and stops per minute the elevator travel seldom gets up to full speed.

be found that one of the first means of conditioning was a hand hammer and chisel which was soon found to be inadequate as only minor defects could be removed, which resulted in costly loss in yield, as billets with deep or excessive defects had to be scrapped.

To overcome this problem, pneumatic hand hammers were adopted and have proven to be efficient, and found to be sound economy when used for chipping billets with light defects on heats of soft or medium hard grade steel. However, on billets that require excessive or deep chipping, the cost becomes prohibitive with pneumatic hammers, presenting again the problem of excessive yield loss, and billets that should be salvaged are scrapped. This is especially true when conditioning billets of high carbon content and hard or tough grade alloy billets, some of which are not only impractical but impossible to chip by hand.

In trying again to overcome high conditioning cost and high scrap loss in the billet form, hand scarfing torches were adopted and are used with success to condition billets of low or medium carbon content, however, scarfing presents a problem when used to condition high carbon or hard steels, inasmuch as the higher carbon and critical alloys are sensitive to the heat shock imparted to such billets from the torch, and they must be preheated prior to scarfing. Pre-heating of billets before scarfing has presented a problem in its own right, and is an addition to conditioning that leaves much to be desired.

Swing frame grinders have been widely used in the industry to condition the higher carbon and hard alloy billets, but this method has never been satisfactory to economy minded operators, because it is a slow and tedious operation, resulting in a very low rate of production, and excessive conditioning cost.

It is reasonable to believe that the foregoing mentioned methods of conditioning were adopted through necessity, and as a line of least resistance, inasmuch as their installation is rapid and the initial cost of the equipment is not excessive.

Mechanical conditioning requires a substantial investment in equipment and facilities, but the general experience has been such as to justify its use in conditioning billets of sizes over 3 × 3 in.

In order to bring out comparative operating economy, a statistical investigation was made of 24,965 tons of billets, in size ranging from 4 × 4 in. to 8 × 8 in. inclusive, from a group of heats of which part of each were conditioned by three different methods. In order to eliminate all possible variables that would handicap one method as compared with the other, the billets evaluated were from heats of mild or medium carbon

Figure 5 — This is the hydraulic valve lever control for the lateral action of the arbor and cutting head. The operator moves the lever in or out and the tool head follows through in the same direction.

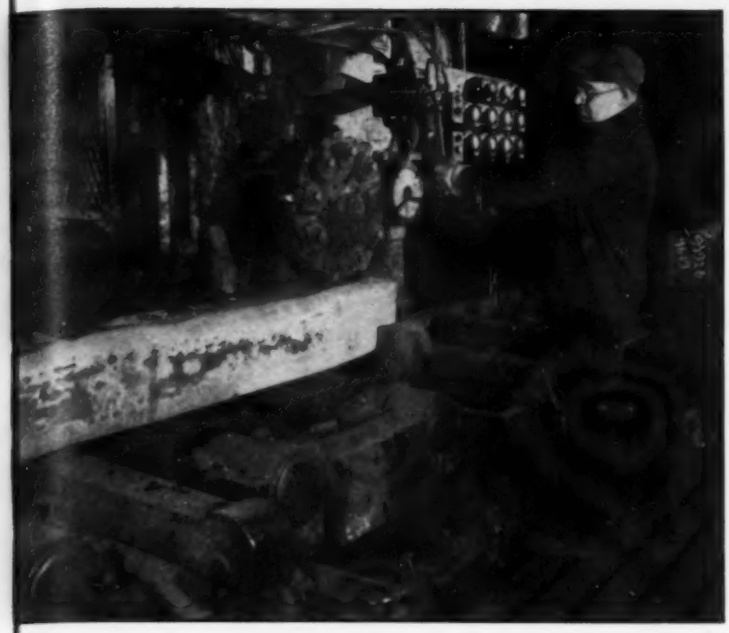


Figure 6 — The machine is in position ready to start chipping the first side of a billet. The operator is in the regular normal working position with his left hand on the hydraulic valve lever and his right hand on the joy stock control switch. As the machine travels forward in the cutting operation, the operator walks along with it.

open hearth steel, which in our opinion resulted in an equitable, conservative, average cost differential. This investigation revealed that it cost 63 per cent more per ton for hand scarfing and 125 per cent more per ton for hand chipping than for machine chipping.

During the five year period prior to November 1, 1946, we machine chipped 714,022 net tons of billets, which we shall assume cost $1.00 per ton to condition. We use the cost differential as revealed in the statistical investigation to show the difference in cost if hand scarfing or hand chipping had been used to condition this same tonnage in the following table:

TABLE I

Method	Tons	Cost per ton	Total cost	Difference
Machine chipping	714,022	$1.00	$ 714,022	.....
Hand scarfing....	714,022	1.63	1,163,856	$449,834
Hand chipping....	714,022	2.25	1,606,550	892,528

It is our opinion that actual operations for the period shown would result in an even much greater cost differential in favor of machine chipping inasmuch as during the past five years more than ever before we have conditioned most of our alloys and billets for the more exacting requirements with the chipping machines.

We have found the chipping machine to be suited to a very wide range of specifications, from dead soft rimmed steel (1010), to 1.00 per cent carbon (1095), and high sulphur bessemer screw stock. It also has the ability to take open hearth and electric furnace alloy billets in stride without any special adjustments on such specifications as silicon manganese (9260), chromium vanadium (6150), high carbon chromium bearing steel (52100), chromium molybdenum (4140), and nickel molybdenum (4815).

We have experienced the best yields on any or all of these specifications from billets that are conditioned with the chipping machines as compared to other methods, with less reconditioning necessary on the finished product, lower finished product rejections, and lower customer rejections when rolled into such products as cold drawing, forging, cold heading, seamless tubing and other special requirement quality.

These billets are all rolled direct from the ingot, conditioned with the chipping machine, then rolled direct into finished product at the merchant mill without any extra conversions or intermediate heating or rolling.

Any billet that can possibly be used for a subsequent rolling can be salvaged with the chipping machine without involving prohibitive conditioning cost. This feature eliminates diversions and excessive scrap loss in event of a bad heat or bad individual billets, and is also important to meeting schedules and reducing the pick-

Figure 7 — This photograph shows a close up of the multiple control switch or joy stick. The lever movements are forward and reverse for the carriage, and up and down for the elevator, the cutting head follows through in these directions at the command of the operator's touch.

Figure 8 — The cutting head is at the completion of chipping of one side of the billet. At this point the operator reverses the carriage and raises the head to clear for manipulation.

up items at the melt shop, thereby holding the required inventory of ingots and billets to a minimum.

In comparison with other methods of conditioning, the safety experience of our chipping machines are far out in front, as our operators and helpers have had but one disabling injury in more than 31 machine years or 490,000 man hours of operation.

Another item deserving of note is that chipping machine chippings are 100 per cent reclaimable as steel melting scrap, while flashings from scarfing have a reclaim value of 70 per cent iron content.

As compared to a pneumatic hand chipping hammer weighing 14 pounds and a hand scarfing torch weighing 6 pounds, the chipping machine is a machine weighing 45 tons, built to withstand the terrific shock of cutting impact.

The ability to do this has been proven beyond any question of doubt, as after 12 full years of operation which averaged 18 turns per week, our first chipping machine is still in first class condition. During this period the cost of replacement parts has averaged less than 5 per cent of total expense charged to the chipping machines for each ton of billets conditioned.

Despite this sturdy construction, the chipping machine is very sensitive to the touch of the controls and the response to action is instantaneous.

Billets are delivered to the chipping machine by overhead crane, in approximately 12-ton lifts, as received from the rolling mill, and placed on the charging skids or feed table, which feeds the billets one at a time to the chipping machine roll line, by means of pusher dogs which are manipulated by pushbutton controls located on the machine within easy reach of the operator. Each billet is next conveyed by the electrically driven roll line to chipping position on the machine, and clamped with three vise-like chucks operated by compressed air.

After the billet is conditioned, it continues on the roll line to the discharge or runoff table, which is entirely automatic in operation, being actuated by the billet striking a flag switch, which sets the pusher dogs in motion, sliding the billet sideways off the roll line, and then returning the dogs to their original position for the next billet. The conditioned billets are removed from the runoff table by the overhead crane and placed in the storage yard without causing any interference to the machine operations when loading or unloading the tables.

The functions of the chipping machine in conditioning billets can best be outlined as follows:

A carriage housing is built to travel or slide back and forth parallel to the table roll line which holds the billet to be chipped. The carriage is mounted on removable cast iron ways or wearing plates and is powered by a worm screw drive. As the billet remains stationary during the conditioning process, the purpose of the carriage is to carry the cutting assembly back and forth over the cutting range.

An elevator housing assembled within the carriage housing, mounted on two worm drive lifting screws, supplies the vertical action to the cutting assembly.

The cutting assembly consists of an arbor or shaft which is assembled within the elevator housing in a large bronze gear as a hub in a wheel, the gear furnishes the rotating motion to the arbor and has four slotted keyways which allows the arbor to slide back and forth sidewise or laterally while the gear rotates. The lateral action is powered by a hydraulic pump and attachments, mounted on the back of the elevator housing at the end of the arbor.

Figure 9 — This photograph shows the air cylinder operated manipulator hook, used in turning over the billet from side to side. This is raised and lowered by the operation of a hand lever air valve.

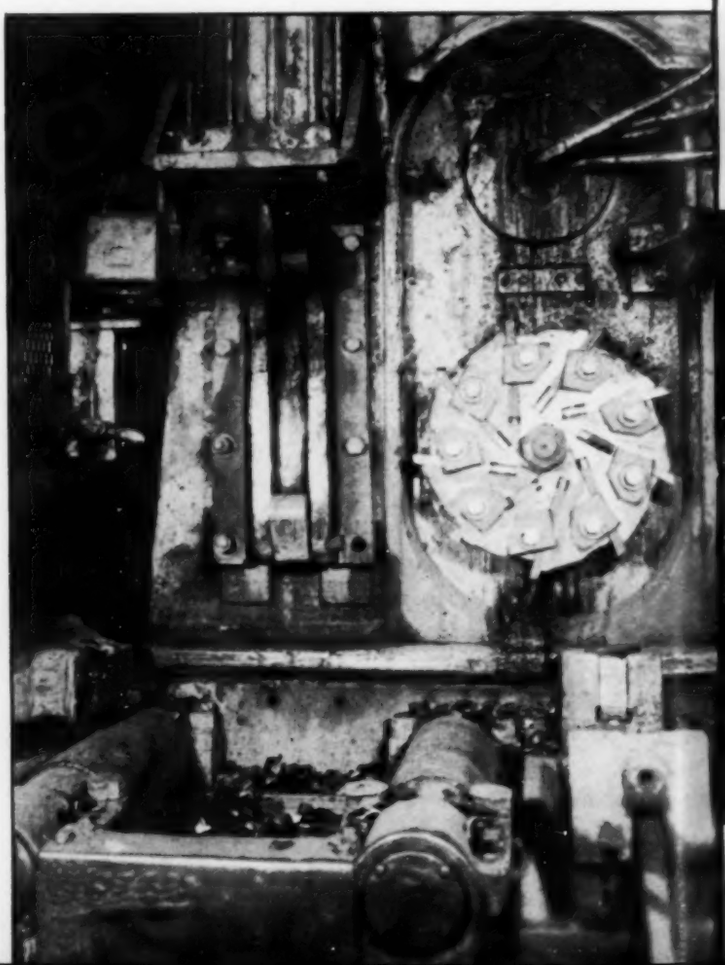


Figure 11 — A group of finished billets on the storage skids is ready to be picked up by crane for delivery to the mill or storage.

The cutting head is attached to the opposite end of the arbor by a single machine threaded bolt and held in place by three dowel or shear pins. The cutting head is circular and slotted to hold eight cutting tools, which are set up or shimmed so that all extend out exactly the same distance or about one inch out of the circle.

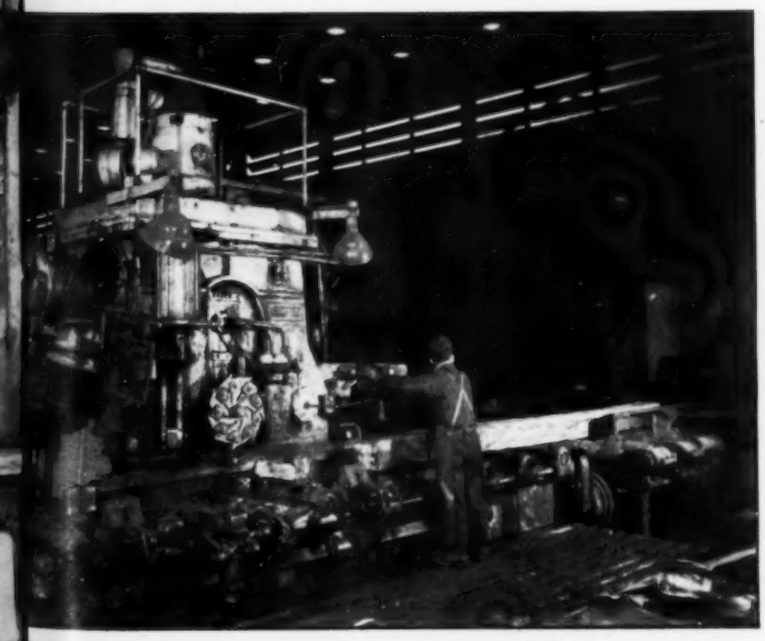
The cutting tools are made of hot rolled, high speed steel bar stock, cut to length, and one end ground to the radius and contour desired to meet cutting requirements, then heat treated to a 63 Rockwell hardness.

The cutting head rotates clockwise, powered by a variable speed motor, and as explained, the lateral action of the arbor, the vertical action of the elevator, and the forward and reverse travel of the carriage give all the action necessary in spot chipping, skinning, gaging or flaring of defects, in conditioning a billet.

These features lend to ease of operation, and lessen the physical effort expended by the operator, reducing his fatigue, thereby contributing to a high rate of operating efficiency.

To those who are charged with the responsibility of billet conditioning, a good rule to follow, is that too little conditioning is labor wasted, and too much conditioning is labor lost, and we believe that the happy medium to this rule can best be found with the chipping machine.

Figure 10 — The finished billet is being run off the machine table toward a flag limit switch at the right hand end of the roll table. This flag when depressed by the billet starts the runout rolls on the runout table. When this flag switch returns to its normal position, it energizes the pusher arm to shove the billet onto the runoff skids. All this is done automatically so the operator can remain at the pushbutton control station.



DISCUSSION

PRESENTED BY

P. E. HAGLUND, Melting Superintendent, Ford Motor Company, Dearborn, Michigan

J. H. VOLLMER, Superintendent Conditioning, Youngstown Sheet and Tube Company, East Chicago, Indiana

M. R. SCOTT, District Engineer, Linde Air Products Company, General Motors Building, Detroit, Michigan

HAROLD CROWDER, Algoma Steel Corporation, Ltd., Sault Ste. Marie, Ontario, Canada

J. L. BUELL, District Manager, Reliance Electric and Engineering Company, 3105 E. Grand Boulevard, Detroit, Michigan

P. S. PALUCH, Superintendent, Conditioning Department, Great Lakes Steel Corporation, Ecorse, Michigan

W. C. PERKINS, Industrial Engineering Department, Great Lakes Steel Corporation, Ecorse, Detroit 18, Michigan

J. H. BUCKNAM, Assistant Superintendent Development Division, Linde Air Products Company, 686 Frelinghuysen Street, Newark, New Jersey

E. FREDERICK BATES, Ceramic Engineer, Ford Motor Company, Dearborn, Michigan

RICHARD W. MILLER, District Manager of Sales, The Columbia Tool Steel Company, Chicago, Illinois

P. E. Haglund: Mr. Vollmer, how many defects are glazed over by the chipping chisels?

J. H. Vollmer: We have experienced very little trouble in that respect, however, one of the first problems that we encountered with machine chipping was a rough cut or tool chatter, when chipping low carbon or soft steel. When chipping medium or high carbon steel the machine makes a clean, smooth cut. We have overcome the rough cut or tool chatter by upsetting the end of the tool, so as to advance the cutting edge past the center line of the tool head, and speeding up the rotating motion of the tool head.

M. R. Scott: Do you do any scarfing in your plant?

J. H. Vollmer: At present at the Harbor Works we are scarfing 100 per cent of our slabs for strip, and about 30 per cent of our billets for the merchant mills.

M. R. Scott: How do you determine what billets go to your scarfing dock and what billets go to your billeteers? Do you have a set procedure on that?

J. H. Vollmer: Our machines are designed to handle billets starting with 3 × 3 in. — 18 ft long, thus eliminating the machine chipping of that portion of our tonnage in billets under 3 × 3 in. and over 18 ft in length. We do not have facilities for preheating billets prior to scarfing, so therefore any billets sensitive to the heat shock from the scarfing torch must be machine or hand chipped. Inasmuch as we lack sufficient machine capacity to machine chip all available billets, we try to apply the conditioning method that is best suited to the various types of products in order to come up with the best possible product with the lowest possible cost.

Harold Crowder: Referring to the billeteer as against scarfing, are the billets that go to the billeteer pickled, and have you a pickle charge that should go with your billet charge to compare with no pickling when you scarf them?

J. H. Vollmer: The end use of the finished product, and the surface quality of the billets, based on inspection and observation reports, governs which billets we pickle. This applies to all three of our methods of conditioning.

Harold Crowder: I wanted to know the cost of the final analysis of scarfing as against billeteer chipping. Now to arrive at that figure as against the information that you have given me, how much of your material that you scarf was pickled or any of it? Comparing the final results, you say the billeteer is very good and you have billeteer chipping, and pickling on the same material. If you hand scarf it, is it also pickled or just scarfed?

J. H. Vollmer: The illustration used in my paper shows a cost differential of 63 per cent in favor of machine chipping over hand scarfing. To arrive at an equal comparison in making this cost study, we used pickled and not pickled billets in equal portions for all three methods of conditioning.

Harold Crowder: If you had high quality steel, you want to produce a very good product, and if you were going to hand scarf it, would you pickle it?

J. H. Vollmer: That is our practice.

M. R. Scott: Would you amplify on the cost figures; that went by pretty rapidly and I would like to take another look at it. The first slide that you showed.

J. H. Vollmer: I would like to point out, that the cost per ton shown for machine chipping is an assumed figure used only to illustrate the cost differential between the three methods of conditioning. I might also elaborate on my statement with reference, "to eliminate variables that would handicap one method as compared with the other." For example, "high carbon or hard steel billets would slow down hand chippers and increase cost, but would not affect hand scarfing or machine chipping. For that reason the billets evaluated were from a group of heats of mild or medium carbon steel of average surface quality with equal portions for each method of conditioning with respects to billet size, pickled, not pickled, etc.

J. L. Buell: It would appear to me that Mr. Vollmer is very much in favor of the billeteer method while in Mr. Paluch's discussion he has concentrated on scarfing or hand chipping. Since I understand Mr. Paluch has several billeteers in his plant, I wonder if he has any comments as to their worth? In other words, where does he stand on this mechanical chipping and where does he use it as compared to hand chipping?

P. S. Paluch: In the first place, I was asked to talk on scarfing and hand chipping, so that is what I discussed. In our plant we have found very good results with the billeteer. It has increased the yield down to merchant mill quite a bit. One thing about the billeteers is that we have a bad time maintaining them in some respects. To me it is a good operation to remove defects from steel, especially on certain types of steel, such as forging steel and high sulphur billets. Our high sulphur billets, as you know, is a very soft grade of steel, and when you scarf it, it flows very easily creating a lot of fin, and also overlapping. On that type of steel we found it best to use the billeteer. One of the faults that I have found with billeteers is this scrapping as you call it. In some cases we have found on soft grades of steel that the end of the cut is just scraped leaving a little in the form of a scab at the end of each cut. And when we finished, the whole billet was the same way regardless of the fact that we slowed the machine down, and when we sharpened the tools we had the same result. So, I would say that there are only certain particular items, in our case, where I would recommend billeteering. In all other respects, I have found scarfing to be the cheapest. We did scarf billets for a long time before we had billeteers and we found that we had very good results with it. During the war, we added the billeteers and we found that we have had very good results with them.

Mr. Vollmer can perhaps answer what they do at his plant on the ends of the billets. With this type of steel, I find at our plant that you have to start off at least about an inch and a half or sometimes two inches off of the end of the billet, and you finish up at the other end of the billet approximately the same distance off the end of the billet. Just how are these remaining defects at the ends of the billets removed at your plant?

J. H. Vollmer: Our general experience in this respect has been good and has not been too much of a problem. We have found that on billets with a normal shear drag, we can machine chip out close enough to the ends, so that any defect left on the extreme end of the billet will be cut off with the crop end of the finished product.

P. S. Paluch: I have found in our plant that we have to resort to hand scarfing these ends or hand

chipping them in order to complete the products.

J. H. Vollmer: We do very little of that. Your problem regarding rough cutting, I believe, could be solved. I do not know what you have done about it, but as I mentioned before, I have had the same trouble, and as I stated in my paper, we are machine chipping dead soft rimmed steel without too much trouble with rough cutting. A lot depends on the type of tool steel you use, the contour and radius of the tool cutting edge, as well as the rotating speed of the cutting head.

I would like to take the opportunity to say here that I am simply stating my opinions based on personal experience with chipping machine performance. I have also found the other methods of conditioning mentioned here tonight to be essential and of importance to the processing of our products.

P. S. Paluch: Along that same line of discussion is the type of material we work on the billeteers. We found during the war years, when we had a lot of chrome-nickel steel that we had to slowcool the steel to work it on the billeteers. If it hardened, we had a hard time. I believe you found the same thing, did you not?

J. H. Vollmer: Yes.

P. S. Paluch: I agree with Mr. Vollmer that certain equipment deserves its credit on certain types of steel, and as I referred to before, the high sulphur billet for one is one that should be billeteered.

W. C. Perkins: How about the automatic mill scarfing? Mr. Paluch's claims, I know, are pretty good. Hand scarfing is a little cheaper possibly. The automatic scarfing cleans the entire surface off as it comes out of the mill in a hot slab. Have either one of you investigated that, or your companies?

J. H. Vollmer: We have been hot scarfing at our blooming mill since 1940. We find the hot scarfing machine an invaluable aid to conditioning on billets ordered to restrictive requirement quality or on any heats that have been observed as poor surface quality prior to rolling at the blooming mill.

W. C. Perkins: What is the purpose of the hot scarfing then if you still have to run it over the bileteer?

J. H. Bucknam: In the hot scarfing process you remove a definite amount of metal from the entire surface of the bloom. On blooms, you desurface all four sides at once, and set the depth of cut at a depth that takes out most of the defects. If you are conditioning a steel that has a lot of small or shallow seams, you can hot scarf deep enough to get them all. If you are running a steel that has, say 90 per cent shallow seams, you will get that 90 per cent, but the other 10 per cent may be so deep that it will not pay to set the machine to go that deep. Those seams that are left after a hot scarfing are the ones that you have to take out after you get farther along in the rolling line. There are a lot of grades of steel where you can roll direct right through and the steel comes out clean. It all depends on how the defects run. The hot scarfing process is not designed primarily to take out all the defects. If you get one defect that is $\frac{1}{8}$ in. of an inch deep, and all the rest of them are under $\frac{1}{32}$ in. of an inch deep, it does not pay to use enough gas to take off an eighth of an inch of metal all around and, although it can be done, it is poor economy to try to do it.

J. H. Vollmer: I would like to add that we found hot scarfing to be an important factor in overcoming man-power problems, and meeting schedules during the war years, through its ability to remove that 90 per cent of the defects.

E. Frederick Bates: Relative to the cutting tools in the chipping machine, could you tell us what sort of steel the cutting tools are made of, and also give us some idea as to the life of the tools? That is, relative to the grinding, how often do the tools have to be ground and how long do the tools last before they have to be completely replaced? Perhaps you could give us some idea as to how many billets you get per cutting tool, before it becomes necessary to regrind them again and to resharpen them. It is obvious that the cutting tools apparently must take a severe beating, if I understand correctly, that the billets are hot, and it is obvious that they take much punishment. Perhaps you could give us some idea as to the life of these tools in relation to the amount of billets that are chipped?

J. H. Vollmer: Your assumption that the billets are hot is not correct. All billets conditioned on the machine are cold, however, the tools do get hot from the cutting operation. You are correct when you say that the tools take a severe beating, as they are subject to a terrific shock from cutting impact, and it has been our experience that too much emphasis cannot be placed on the selection of the type of tool steel, and the heat treatment for this work. The life of the tools, I would say, depends a great deal on the grade of steel you are conditioning. On the average we are getting 6 to 8 hours cutting edge life between grindings, we find it good practice to send them to the heat treating shop for rehardening after seven or eight grindings, our tools are rehardened on the average of seven times before they become too short to hold in the tool head. Our tools are $2 \times \frac{3}{4} \times 6\frac{1}{2}$ in. when new, and used to $2\frac{1}{2}$ in. in length when discarded. This means that we are using 1.7 lb of each tool in approximately 350 hours of service, and as we are averaging 6.35 tons of billets chipped per machine hour with eight tools in the cutting head, we get approximately 251 tons chipped for each 1.7 lb of tool steel used.

Richard W. Miller: The tools are a standard 18-4-1 high speed — a special carbon about 0.60 per cent. It is electric furnace high speed. The important factor of the whole chemistry, in relation to this application I believe, is the low carbon.

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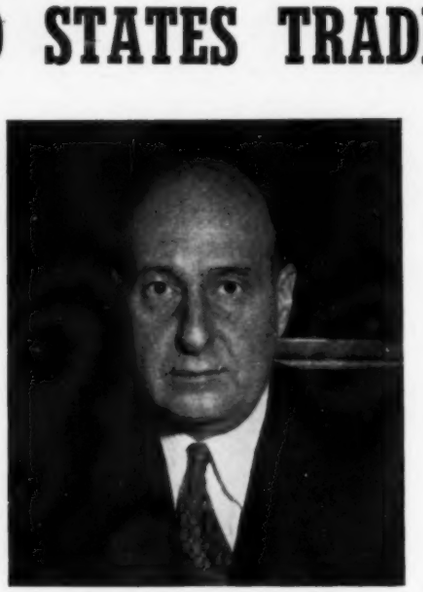
Economic Factors

IN CANADIAN AND UNITED STATES TRADE

By R. A. GILLIES, President
Steel Company of Canada, Ltd.
Hamilton, Canada

. . . . a large number of the AISE members of the Buffalo Section are located in Canada, and it was particularly fitting that, at the banquet address of the AISE Spring Meeting in Buffalo, one of Canada's leading industrialists should explain Canadian and United States economic relations . . . .



R. A. GILLIES

▲ IN this time of world upheaval, it is desirable and necessary to have understanding between countries holding to the same ideology. Because we Canadians believe that the people of the United States, our powerful, prosperous and friendly neighbor, tend to take Canada for granted, I shall describe, briefly, Canadian institutions. I shall also try to give an understanding of the trade relations between our two countries, and at the same time some idea of the economic problems which Canada now faces. In the course of this discussion, I hope to make it clear that Canada has played a great part in assisting the recovery of a war-torn world.

First of all we will point out a few facts. Canada is big in area — being about one-sixth larger than the continental United States. It has, however, only about one-twelfth of the population of the United States; and moreover, about 60 per cent of that population lives in the two provinces of Ontario and Quebec, which together make up about one-quarter of the area of the country. Canada has approximately 3½ people per square mile, as compared with 50 people in the United States. But on the basis of fertile land, the disparity in population density is by no means so great.

About one-third of the Canadian people speak French, so the country has two official languages: English and French. All our money, postage stamps, public documents, and the proceedings of our Federal Parliament are printed in French as well as English.

As it is hardly necessary for me to tell you, Canadians have a friendly attitude towards the United States, and are interested and well informed as to your politics. Our newspapers deal largely with American news items such as the "goings-on in Washington," the activities of John L. Lewis and Phil Murray, and even the philanderings of Hollywood stars.

Our standard of living is not substantially different from yours. We are, in the main, well housed, well clothed, and we eat about the same foods as you do. While there may not be as many cars in proportion to the population, still there are sufficient to create a traffic problem on our highways.

Wages per hour are somewhat lower, but speaking generally the work week is a little longer, so that weekly earnings are not so very far below those in the United States. Generally speaking, the cost of living in Canada tends to be lower, although there is considerable variation in such costs in different cities. One of our men who came to Hamilton from Gary about two years ago has estimated that his cost of living in Hamilton is not more than 70 per cent of what it cost him to live in Gary on the same scale.

Personal taxes in Canada during the war were higher than those in the U. S., but these came down approximately to your rates about one year ago. With your recent tax reduction, a differential has again been created, so there is already agitation for a reduction in our taxes to the same relative level. Since we too probably have an election facing us within the next twelve months, I do not doubt that tax reduction is in the making. Our tax structure is generally the same as yours with one important exception. In Canada, we have no capital gains tax, so that anyone who is smart enough to make a profit from trading is not taxed on that profit. On the other hand, capital losses may not be deducted from taxable income.

To sum this up, the average person in Canada lives only slightly, if at all, below the standard of the average person in the United States, and this in face of the fact that our national income in dollars per person is only about two-thirds of that in your country.

Politics in the two countries look much the same.

Presented before AISE Annual Spring Conference, Buffalo, New York, April 26, 1948

Perhaps in Canada we are a little more "old-fashioned," in that we have no primary elections. But all candidates for membership, either in the Federal Parliament, or in the Provincial Houses of Assembly, are nominated in constituency conventions. These constituency party conventions lack the excitement of your state primaries, or the color of your great national conventions, but they are interesting, because they follow a pattern which has persisted for many years. At such a party convention, each candidate for nomination in that particular constituency gives a talk setting forth his ideas, and stating why he should receive the nomination of the party. After all the candidates have been heard, the convention makes its choice by ballot. After nominations, elections are held in Canada in the same manner as you held them down here.

Canada is governed by a House of Commons and a Senate. The House of Commons is elected as you elect your House of Representatives, with representation from each constituency. However, our Senate, unlike yours, is appointed for life. As vacancies occur in the Senate, they are filled by the Government in power, but the Canadian Senate does not play the important part in Government that your Senate does, since very few bills of importance originate in it. No bills calling for the expenditure of public funds normally originate in our Senate.

Canada does not elect the head of its Government in the way that United States elects its president. The leader, selected by a convention to be the head of the party which holds the most seats in Parliament, is automatically head of the Government. He is supported by a Cabinet, the membership of which is also chosen from elected members of the dominant party in Parliament. Thus, both the Prime Minister and our Cabinet members have all been elected to Parliament as representatives of their particular constituencies.

Normally, the Federal and Provincial Governments hold office for five years, but there is no fixity of tenure such as prevails under your system. If at any time the government, or the Cabinet, if you like, fails to hold the support of a majority of Parliament, a new election must be called. Should the opposing party in such an election elect the greatest number of members to the new Parliament, then the old Government goes out and a new one takes its place. Under this system, the head of the Government must at all times have the support of Parliament. We cannot have situations such as now present where Mr. Truman may be practically powerless to make changes, because an opposing party is in control of Congress. The Canadian system is not perfect, but it does tend to make for prompt action.

There is another thing I should point out; that is, all judges in Canada are appointed for life, even down to the lowest police court justice. This, we feel, has kept political influence on judicial decisions to the minimum. All in all, I believe that Canada has been fairly well governed, but, as in other democracies, partisan political considerations must have a large influence upon government action.

Canada is still largely an agricultural country, although the shift in population from rural areas to urban areas has been very marked over the past 20 years, particularly in the prairies provinces. Wheat is still our primary agricultural product, and it is sold throughout the markets of the world. Fruit production is very substantial in some parts; we also produce large quantities of potatoes, especially for seed. We have large dairy interests, and these have proved so powerful that margarine cannot legally be sold in Canada; and we raise cattle and hogs upon a substantial scale. Practically all of these agricultural products are produced in more than sufficient quantity to feed our own population, and thus we have large surpluses which must find markets abroad.

Canada's forests supply large quantities of lumber to Britain; and the bulk of your newsprint, as well as increasing quantities of your pulp and diminishing quantities of your pulpwood. From our mines come gold, silver, nickel, copper and other non-ferrous metals; all of which products go mainly into world markets. Recently, Canada has sold some iron ore, but the tonnage has not yet become substantial, and is not nearly enough to supply our own iron ore requirements.

The Canadian primary products I have mentioned are very important to the world, and they make Canada the first exporting country of the world, on a per capita basis.

Canada is normally the world's largest exporter of cereals, non-ferrous metals and forest products. In total value of exports, it now ranks as the third exporting country.

Canada has also become considerably industrialized. While our steel industry is relatively small; total production being something less than 3,000,000 tons per year — less than one-half of the per capita production of the United States — still in many lines Canada now manufactures sufficient to meet its home requirements. We are also able to do some industrial exporting in certain lines. Our exports of agricultural implements are large, and we ship automobiles overseas to some extent.

Speaking generally, however, our industry has been developed to take care of our domestic demands. Being so close to such a great industrial country as the United States, we find it much easier and more economical to buy many of our manufactured requirements from you. This situation has, I believe, held back Canada's industrial development to a substantial degree; but on the other hand, it has given us the advantage of ready access to your products, and this has helped make possible the high standard of living which Canada enjoys.

In recent years, Canada has made real progress in her industrial development, but this has not led to any lessening in the demand for your products. On the contrary, the steady rise in our standard of living has been accompanied by a concurrent rise in our demand for U. S. products. We have now reached the stage that Canada tends to buy from the United States approximately twice as much as the United States buys from Canada. The 1947 figures, in round numbers, show that Canada bought your goods and services to the extent of two billion dollars, while the United States bought from Canada products and services valued at only one billion dollars. This is the situation I should now like to discuss in an endeavor to make clear to you the difficult position in which Canada now finds itself.

Canada has always had to get from you certain of her raw materials. In the steel industry, for instance,

two of our three major companies depend on you for coal, and for most of their iron ore. Our textile industry is largely dependent on you for its raw cotton. Our manufacturing industry is dependent on you for much specialized machinery which is not manufactured in Canada.

In 1947, Canadians bought more from you than you bought from us in the following amounts: iron and its products, $668 million; non-ferrous metals and minerals, principally coal and petroleum, $434 million; fibres, textiles and textile products, $207 million; agricultural and vegetable products, largely citrus fruits and salad ingredients, $104 million; chemicals and allied products, $62 million; miscellaneous commodities, $120 million.

Against these large Canadian purchases in the U. S., we sold you $528 million worth of forest products, principally newsprint, and $37 million more animals or animal products than we bought from you.

All in all, you sold us some $942 million more of the commodities I have listed above than the value of what we sold to you. This has been a long-standing condition, and is not too serious, when the world is functioning normally. Under normal conditions, while we did not sell directly to you nearly enough to balance our account, we did sell to the rest of the world sufficient quantities of primary and manufactured products, either for dollars or for funds easily converted into dollars, to enable us to pay for what we bought from you. That condition has now changed very definitely. So, despite the fact that we were still exporting more than we were importing, our exchange reserves became depleted. Last autumn, Canada found herself running out of foreign exchange, very much like the merchant who must pay for his stock in cash and who has extended credit until there are insufficient funds with which to buy more goods.

Thanks mainly to U. S. purchases in Canada during the war, at the end of 1945 Canada had foreign exchange reserves in gold and United States dollars of $1½ billions. That was about one billion more than we normally have, and was regarded as substantial, and adequate. But, by November, 1947, our reserves had dropped to $500 million. With reserves declining at such a rate, it was obvious that, within a short time, Canada would be without exchange reserves, and, thus unable to pay for its essential import needs.

During 1946, Canada had a favorable trade balance overall of about $450 million dollars, plus about $100 million dollars from the inflow of new capital. This, by itself, would have increased Canada's exchange reserves by about $600 million dollars, but for the fact that in the meantime, Canada had given to Britain and other countries, credits to the extent of some $750 million dollars. In addition, Canada exported something over $100 million dollars through U.N.R.R.A. and Mutual Aid. So, instead of increasing our reserves by $600 million, there was actually a reduction in such reserves of more than $150 million.

In 1947, the picture was much the same. We had a favorable trade balance overall of some $200 million dollars, but again we granted credits to the extent of over $550 million, and we made gifts for European relief of approximately $40 million. On top of all this, we subscribed $74 million dollars to The International Monetary Fund, and made other capital payments abroad of about $140 million dollars. In total, there was a net drain on Canada's store of gold and U. S. exchange of approximately $750 million dollars.

In both of these years, the loss of exchange was primarily due either to outright gifts to Great Britain and European countries, or to the extension of credit to those same countries for the purpose of allowing them to purchase from us the very necessities of life. These sums may no longer sound very large to you in the United States, accustomed as you are to dealing in hundreds of billions of dollars, but, in proportion to Canada's population, about 12½ million, they are very large indeed. I venture to say, in fact, that no 12½ million people in history have ever attempted so ambitious a program of financing international rehabilitation.

By the middle of 1947, Canadians began to realize that they could not continue to carry on in this way, and it was decided that steps must be taken to balance outflow with income. After careful consideration, our government decided that the best way of meeting the immediate situation was by limitation of imports from the United States, especially the import of non-essentials. By acting in this fashion, it was hoped that we could continue to extend credit to countries which needed credit, without creating hardships at home, and without having any harmful long-range effect on our trade relations with you. In November of last year, the Canadian Government, therefore, issued orders limiting imports from the United States. We can no longer buy your expensive cars, nor many other of the luxuries with which you have long supplied us. We can, however, continue to buy your machinery, raw cotton, coal, petroleum, and other essentials.

While it was a drastic and most distasteful step for our government to take, still I believe it was the only one possible, if Canada was to continue as a self-reliant country living within her means. It was especially necessary if we were to continue to make our contribution to the reconstruction of war-torn Europe in general, and Britain in particular.

All through the war, Canada purchased great quantities of goods and materials from the United States, all of which were paid for in cash. At the same time, Canada made large gifts to her allies. For instance, in March, 1942, Canada made an outright gift of one billion dollars to Great Britain in order to assist that country in making purchases of war materials necessary for the continuance of her great effort on behalf of freedom. This was followed later by the Canadian equivalent to your lend-lease, under which two billion dollars was provided to our allies. This is perhaps a good place to remind you that Canada herself was not a beneficiary under lend-lease, nor was she a borrower in the U. S. money market at any time during World War II. In fact, Canada established a world record in the extent to which she paid for her war effort — a gigantic effort for a country of her limited population — out of current taxes.

There were also other forms of assistance both during the war and immediately after, which added another $1,600,000,000 to the given figures. By putting these figures together, it is easily seen that Canada has done her full share, both during the war and in this period of reconstruction. If we compare the Canadian and

U. S. contributions and credits on the basis of national income, Canada's contribution is the equivalent in gifts and credits by the United States of some 32 billions of dollars. Throughout this entire post-war period, Canada has sold and is still selling to Great Britain food products at prices far below those prevailing on world markets.

Canada considers European recovery to be the most important problem in the world today, and feels that neither she nor the United States can ignore it, or fail to undertake a share in its solution. If Canada is to help Europe to the necessary extent, she must continue to forego some purchases from the United States. I think you will be interested in knowing that, on the average, Canadians spend about $220 per capita yearly in the U. S., whereas Americans spend just about $12 per head per year in Canada. If you in the United States would increase your Canadian spending individually, even to a very limited extent, our ability to purchase from you would be greatly improved. In fact, what is only a ripple in your economy becomes almost of tidal wave proportion in our own.

We hope the United States' public realizes that Canada, even with prevailing restrictions, is still by far its best customer, and that each of you has an interest in what may happen to the Canadian economy. Because of our unique relationship with you, it seems to me that it would be worthwhile to direct the attention of the American public to the importance of Canada in American affairs. We do not believe, for instance, that the ordinary visitor to Canada appreciates that the money he spends on a Canadian holiday goes a long way towards paying for what we import from you, and so may have a substantial bearing on the United States production and employment.

Many of you here tonight, have enjoyed Canadian holidays and hunting and fishing trips. One of the easiest and most pleasant ways of correcting the present unbalanced trade condition would be to increase your present $12 annual per capita expenditure in Canada by making more visits of longer duration.

Canada, despite the strain of six years of war, is becoming better equipped to provide the facilities with which to make your Canadian visits more pleasant. Now that the International Trade organization seems a bit nearer to becoming a reality, we hope the time will come when your country will feel able to give Canada better access to your tremendous market. For the more we can sell to you, the better position we are in to continue our large-scale purchases from you. While some of our products may be competitive, rather than complementary, we do feel that our trade with each other can be developed on a basis of our respective abilities to produce the products which we can most economically make. With a freer flow of commerce between our two countries, trade will undoubtedly increase to our mutual benefit.

In closing, I would like to sum up by saying that Canada wishes to be better understood by the American people, so that there will not appear in your press, statements such as recently appeared in one of your Arizona papers, which demanded to know why Canada should be put on a kind of International W.P.A. by the taxpayers of the United States. The article went on to say that the proposed projects under the Marshall Plan called for goods from Canada to be paid for in United States' dollars, and that, since we Canadians refused to assume our part of the burden of reconstruction, you Americans must assume it for us.

I have tried to point out that Canada has carried its share in reconstruction; that, with a population of less than one-twelfth of yours, and with a national income of approximately one-eighteenth as large as your own, the Canadian contribution to European reconstruction has, in fact, been roughly one-fifth as much as that of the U. S. It cannot fairly be said of Canada that she has not and is not doing her share toward rebuilding Europe, as Walter Lippman was at pains to make clear in his reply to that Arizona editor. I have endeavored to explain to you the reasons for Canada's present policy of restricting imports from the United States. It is not that we do not want to buy, but that we are running out of the means with which to do so. We do not, of course, expect your people to spend as much per capita in our country as we do in yours, but we should like to feel that our lakes, mountains and woods will be an inducement to you to spend more of your time in Canada, and thus increase our ability to buy from you.

Finally, I hope I have contributed something towards your appreciation of Canadian problems, and, in the hard years ahead, we may have tolerance born of understanding, and shall thus continue to work harmoniously together for world betterment.

WANTED—Yearly Proceedings!

The Association of Iron and Steel Engineers would like to obtain copies of the following issues of the Yearly Proceedings:

1938
1940
1941
1942
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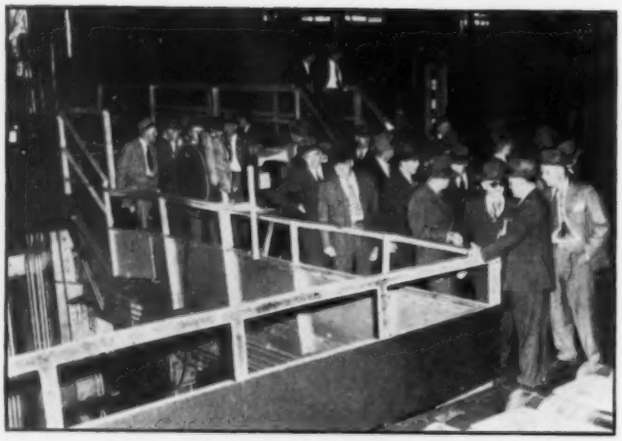
If anyone has copies of any of these volumes available please contact:

ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING PITTSBURGH 22, PENNSYLVANIA

AISE Pittsburgh District Section Visits Weirton Steel

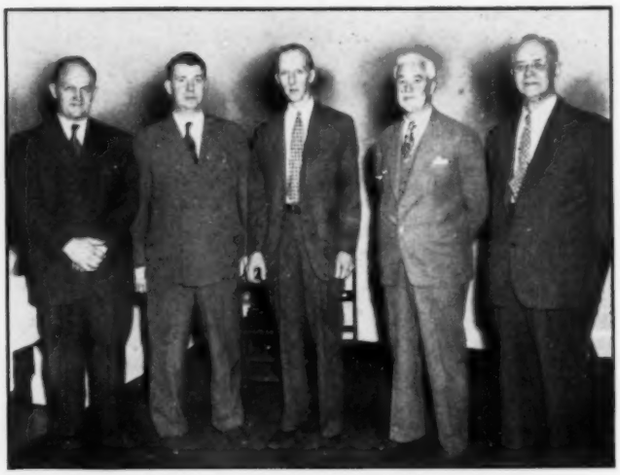


For the inspection trip, the visitors were divided into a number of groups. Shown here is one of the groups on its way through the plant.

The outstanding event of the year for the Pittsburgh District Section was its Inspection Trip to the Weirton Steel Company, Weirton, West Virginia on Monday, May 10, 1948. Blessed by perfect weather, and with all details perfectly planned and executed by the Weirton Steel Company management, over 500 AISE engineers and operators took the opportunity to observe the facilities and operations of the Weirton plant. The trip, which took the whole afternoon, covered practically the entire plant and included the coke plant, blast furnaces, open hearth, blooming mill, bar mills, structural mills, strip mills, the sheet mills, and the tin plant.

Great interest was shown in the mile-a-minute, five-stand, four-high cold reduction, tandem mill. This mill was the subject of two papers in the evening.

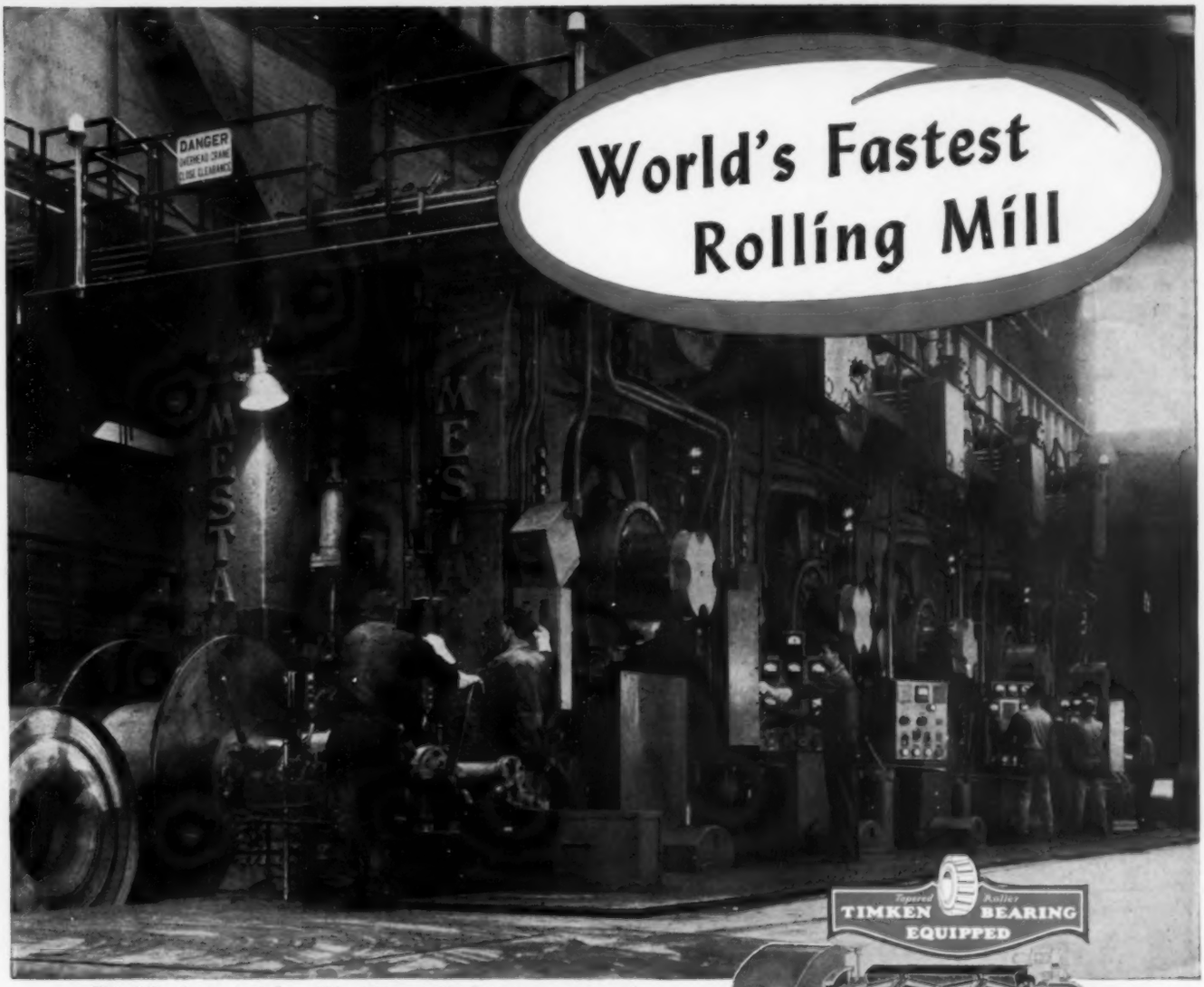
After the long hike through the plant, it was with relief that the visitors adjourned to the social hour at the Williams Country Club, and a buffet dinner. It was also a pleasant surprise to find that the Weirton Steel Company had become host to the group, and that the previously announced tariff was no longer in effect.



Some of the guests at the speakers' table are shown left to right, C. J. Klein, chief engineer, Weirton Steel Company (an author); A. F. Kenyon, steel mill engineer, Westinghouse Electric Corporation (another author); John Young, chairman; E. W. Rieger, vice president in charge of engineering and research, Weirton Steel Company; and A. W. Duncan, retired electrical superintendent, Weirton Steel Company, and an old timer of the AISE.

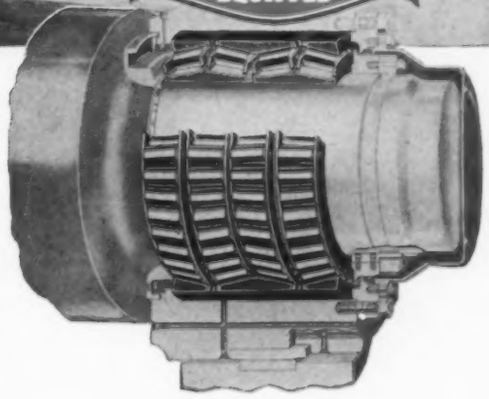
Dinner was served buffet style. At the head of the line is shown Freeman Dyke, assistant general manager, Wheeling Steel Corporation, and a past president of the AISE.

Following the dinner, W. A. Murphy, executive vice president, and E. W. Rieger, vice president in charge of engineering and research, Weirton Steel Company, officially welcomed the AISE group. The formal part of the program was then led by John Young, chairman, Pittsburgh District Section, and vice president of engineering of the National Tube Company. Two papers were presented, the first by C. J. Klein, chief engineer, Weirton Steel Company, "New Cold Mill at Weirton Increases Tin Plate Capacity," and the second by A. F. Kenyon, steel mill engineer, Westinghouse Electric Corporation, "Electrical Drive Equipment for New High Speed Tandem Mill at Weirton."



World's fastest strip mill photographed from entry end.

USES TIMKEN® BEARINGS



Designed, built and installed by Mesta Machine Company for the Jones & Laughlin Steel Corporation, this new five-stand tandem cold strip mill with all work rolls mounted on Timken Roller Bearings has attained a top speed of 6,250 feet per minute in the production of high quality cold-reduced strip in tin plate gauges and widths. This is the highest speed ever recorded by any rolling mill in the world.

Extremely high rates of acceleration and deceleration are also important characteristics of this mill. The operator reports that it can be accelerated from a threading speed of 300 feet per minute to 4,500 feet per minute in *six seconds!* It is the first five-stand tandem strip mill to have separate motor drives for each work roll of the last three stands.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
ROLL NECK BEARINGS

In addition to the application of Timken Roller Bearings on the work roll necks, Timken Thrust Bearings are used in conjunction with the Mesta back-up roll bearings. Mill drives and auxiliary equipment also are equipped with Timken Bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address "TIMROSCO".

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▱ BEARING TAKES RADIAL AND THRUST → LOADS OR ANY COMBINATION →

Because of Low Resistance—

BUSS FUSETRONS

Prevent Costly Shutdowns

REDUCE HEATING

In Panelboards and Switches

Three Typical Examples Prove That Fusetrons Operate Cooler

1 In An Office Building

"We manufacture and install panelboards and switches. About 1941 we were called in by the Investment Building, Washington, D. C. to solve a panelboard heating problem. The panelboard, not of our own make, was equipped with pull-out fuse blocks which, when inserted in the panelboard, are completely surrounded by bakelite. There is no chance for any heat to escape. The 400 ampere one-time fuses then in use in the panelboard were heating to the point where they were causing oxidation of the clips. We recommended the installation of 400 ampere Fusetrons in place of the one-time fuses and no heating trouble has since been experienced.

"We had another chance to prove how Fusetrons reduce heating at . . .

2 a Large Plant

"When the HI Ice Cream Company complained that they were having heating trouble in the 600 ampere main switch bought from us. The ordinary one-time fuses were heating to the point where the fibre was charring. By replacing the fuses with solid copper bars we proved that contacts within the switch were good and that the heating trouble was coming from the fuse itself. Then we installed 600 ampere Fusetrons. That was about 3 years ago. Not a Fusetron has been replaced and the panel is operating at normal temperature."

The Shull Electric Products Corp.,
Arlington, Va.
Frank Shull, President

3 Another Office Building

"When the 400 ampere switches in our lighting panelboard were fused with 400 ampere renewable fuses we were troubled by fuse blows occurring at least once a week. Some fuses were loaded with 3 — 200 ampere links and clip clamps were used to insure good contact in the clips, but the fuse blows continued.

"In many instances, the fibre tubes of the fuses were completely destroyed by the heat.

"Our former Chief Electrician in April, 1945 installed 400 ampere Fusetrons in these switches. To date, February, 1948, not one Fusetron in these switches has been replaced, and the heating has been entirely eliminated."

Henry Williamson
Chief Electrician

BUSS

Fusetrons' Cooler Operation Reduces Needless Blows—Keeps Circuits Operating

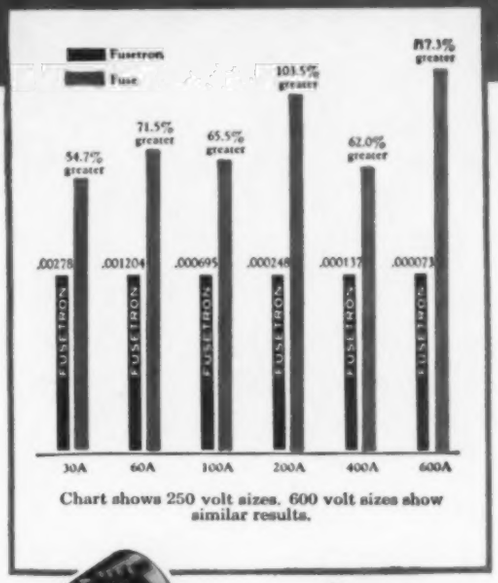


Chart shows 250 volt sizes. 600 volt sizes show similar results.

Switches and panelboards stay cooler with Fusetrons, because Fusetrons cut down heat at its source. The amount of heat produced is in proportion to the amount of resistance. Since the resistance of Fusetrons is very much less than that of ordinary fuses, Fusetrons operate at lower, more efficient temperatures.

This cooler operation eliminates needless blows and useless shutdowns that are the result of heating in fuses. Cooler operation also lengthens the life of switches and panelboards.

By Actual Test, Even The Lowest Resistance Fuse Has 55% to 140% Greater Resistance Than a Fusetron

That's why Fusetrons reduce heating, assure more efficient operation, keep circuits operating and reduce costly shutdowns.

It will pay you to install low resistance Fusetrons, and cut down heating at its source.

What Is The Fusetron?

The Fusetron is Bussmann's dual element fuse.

The result is a fuse with tremendous time-lag and much less electrical resistance.

Fusetrons have the same degree of Underwriters' Laboratory approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimensions as ordinary fuses, Fusetrons fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere in both 250 and 600 volt types. Also in Plug types for 125 volt circuits.

Their cost is surprisingly low.

Fusetrons do everything fuses do, as is confirmed by the Underwriters' Laboratories Label, and in addition . . .

★ Entirely wipe out needless blows caused by motor starting currents or other harmless overloads. ★ Give Thermal Protection to Panelboards and Switches. ★ Lesser resistance means cooler operation and prevents needless blows caused by heating in panels and switches. ★ Permit use of larger motor or adding more motors on circuit WITHOUT installing larger switch or panel. ★ On new installations, PROPER size switches and panels can be used instead of OVERSIZE. ★ Protect small motors against burnout simply and inexpensively. ★ Give DOUBLE protection to large motors. ★ Provide simplest way to stop burnouts from single phasing. ★ Protect coils, transformers and solenoids against burnout.

Get All The Facts
Get Better Protection *. . . Send The Coupon Now*

One needless shutdown — one destroyed switch or panel — one burned out motor may cost you far more than replacing every fuse with a FUSETRON.

Don't risk such losses — protect yourself by changing over your entire electrical system to FUSETRONS.

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St. Louis 7, Mo. (Division McGraw Electric Co.)

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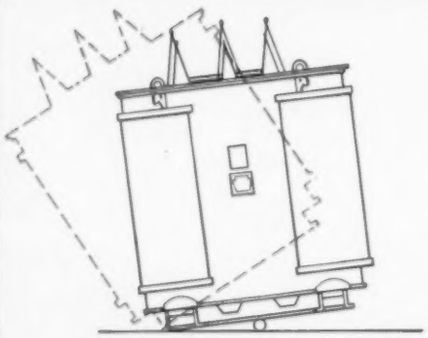
This Time with a Definitely NEW, IMPROVED BASE for Single and Three Phase Power Transformers

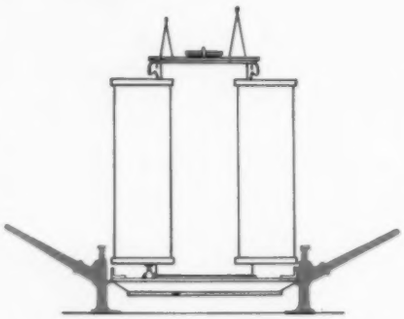
After a thorough study of customer requirements, Pennsylvania Engineers have perfected a base design to meet the needs of the greatest number of transformer users.

NOW, Pennsylvania presents the ultimate in transformer base construction, again illustrating Pennsylvania's versatility and its regard for solving basic transformer problems.

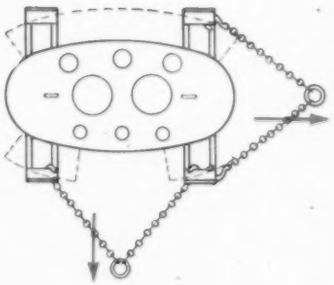
3750 Kva, 3 Phase, 60 Cycles, OISC, 55°C 12000△-2400△/4160Y volts. Inert Gas, Oil-Seal System.



TIPPING Base design takes into consideration transformer's center of gravity. The largest rolls used cannot tip transformer past its center of gravity.

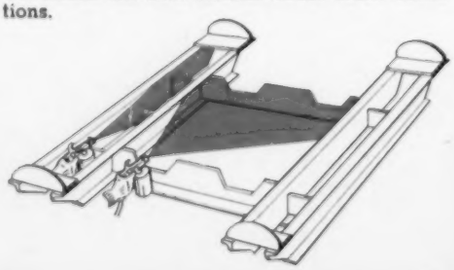


JACKING Structural base members extend to ends of radiators. Radiators offer no interference to jacking. Clearance provided for base of jack to extend under jack lugs. This allows toe of jack to enter all the way under jack lug, and exert the full strength of the jack on the transformer.



PULLING Jack lugs are constructed so that a standard hook can be placed in the jack lug to pull the transformer in any direction. Radiators offer no interference when transformer is pulled.

PAINTING Ports are provided in base members to ventilate bottom of transformer tank, and to facilitate complete painting of the base and tank bottom. Rust will not attack the tank bottom under these conditions.

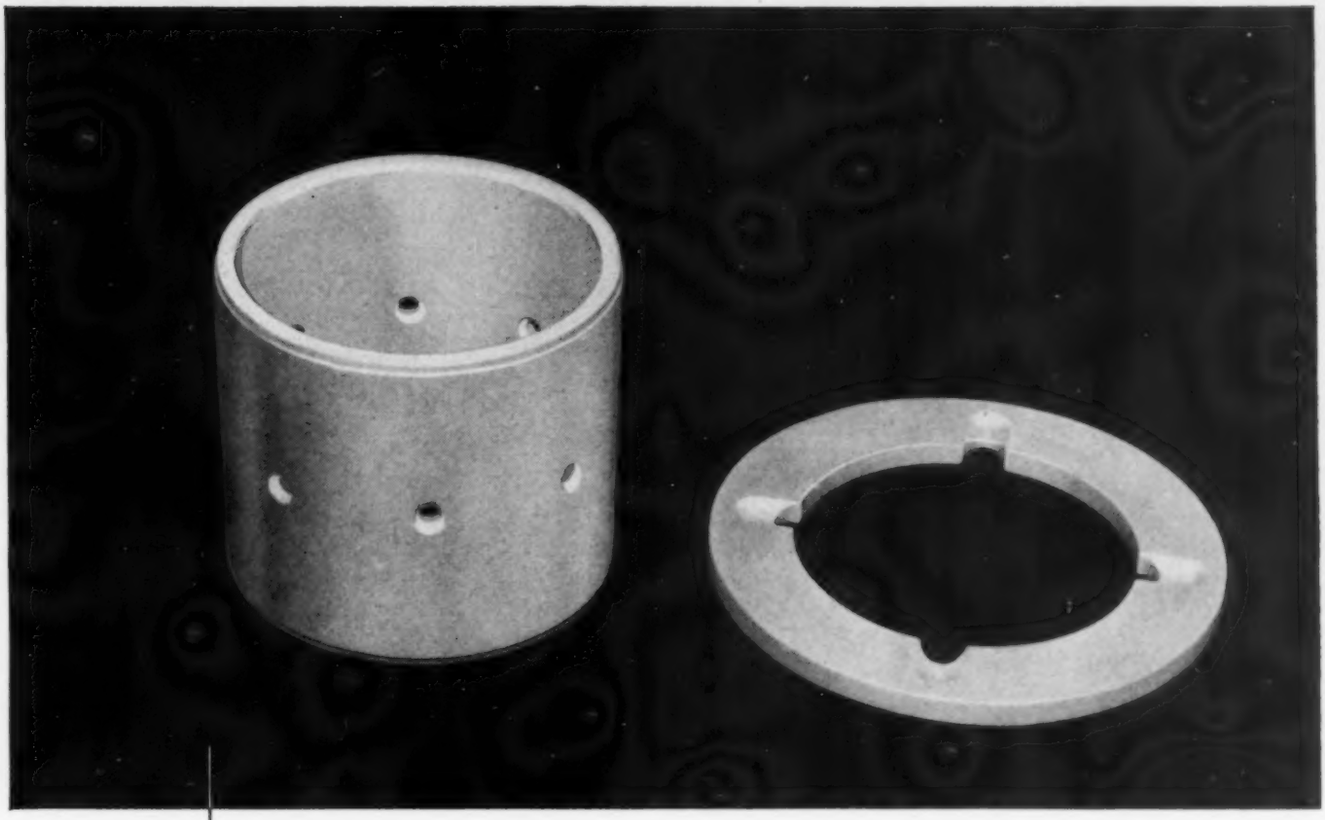


Pennsylvania TRANSFORMERS

Pennsylvania

TRANSFORMER COMPANY

808 RIDGE AVENUE • PITTSBURGH 12, PA.



Longer bearing life means extra dollars

N-B-M Bearings prove their extra value in the mill — and in the accounting department

The first cost of a bearing is almost always misleading — it's the first cost plus *service-life* that gives the final answer as to whether or not you are getting economical bearing service.

That's the approach taken by National Bearing Division: To make a complete engineering study and to design a bearing "tailor made" to your own service conditions. Only this approach is successful — in one case National Bearing Engineers designed a bronze bearing which lasted many times longer than the bearings formerly used.

The purpose of National Bearing research and manufacturing development is twofold:

1. **To design for the specific application, and**
2. **To maintain production standards which assure better bearings — bearings that make important dollar savings.**

Let National Bearing's specialized approach help you reduce bearing maintenance costs in your mill.

N·B·M

AMERICAN Brake Shoe COMPANY

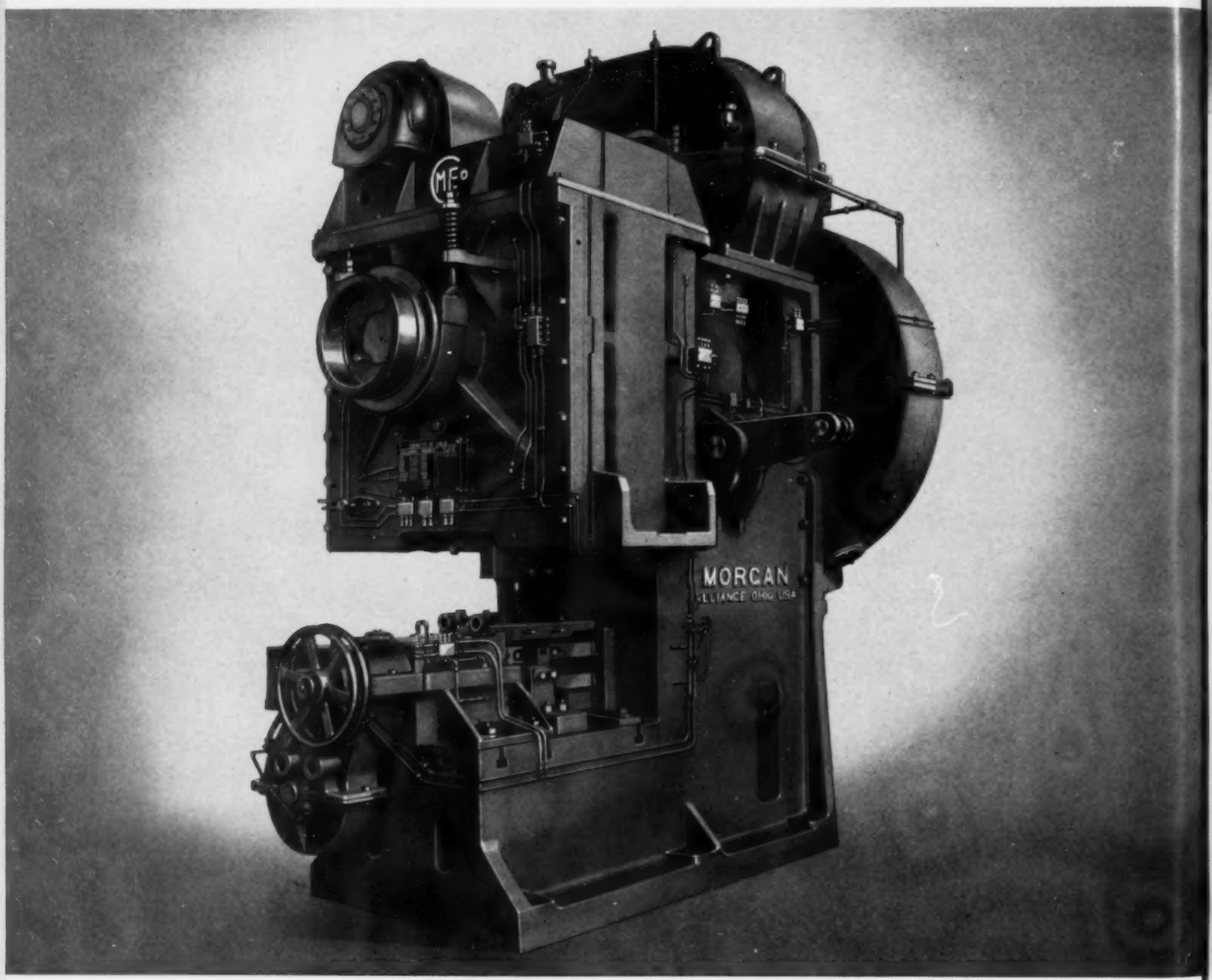
NATIONAL BEARING DIVISION

ST. LOUIS • NEW YORK

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

BUILT BY MORGAN Engineering

MORGAN 600-TON MOTOR DRIVEN STRUCTURAL SHEAR



Illustrated is a Morgan 600-Ton Motor Driven Structural Shear for shearing products from a Morgan 29″ and 23″ Rail and Structural Mill. It will shear up to 4½″ x 4½″ Billets and 4½″ Rounds; Eye Beams and Channels up to 15″; a full line of Angles with equal and unequal legs up to 8″ x 8″; also Fish and Tie Plates.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

NEWS SUPPLEMENT JUNE, 1948

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

WAX PATTERNS INSURE GREATER ACCURACY IN PRECISION CASTINGS

▲ In 1943, Allis-Chalmers installed precision casting equipment capable of producing 600,000 supercharger buckets a month at its plant, and during the rest of the war, literally millions of blades were cast. To speed getting into production, equipment for this plant was patterned after that already in use elsewhere. However, development work to improve the process and equipment began almost immediately, and in 1944 the company set up a pilot plant at its West Allis works to do research and development on precision casting in connection with other war contracts.

Precision investment casting at Allis-Chalmers is done by the familiar "lost wax" process. Patterns of the desired part are produced by the injection of wax into metal dies. The patterns thus formed are assembled on wax sprues, and a refractory material is poured around them and allowed to harden. Melting the wax out from the block of hardened investment leaves a cavity into which metal is poured to form the casting. After the casting is cleaned, the individual parts are cut free from it and smoothed over at the gate by grinding.

As carried out in this foundry, the process is unusually simple and free from unnecessary operations and complicated equipment. Instead, standard foundry technique is used wherever possible. Where machines speed production and lower cost, as in pattern production, they have been highly developed; but where they needlessly complicate the process, as in pressure or centrifugal casting of metal, they have been eliminated.

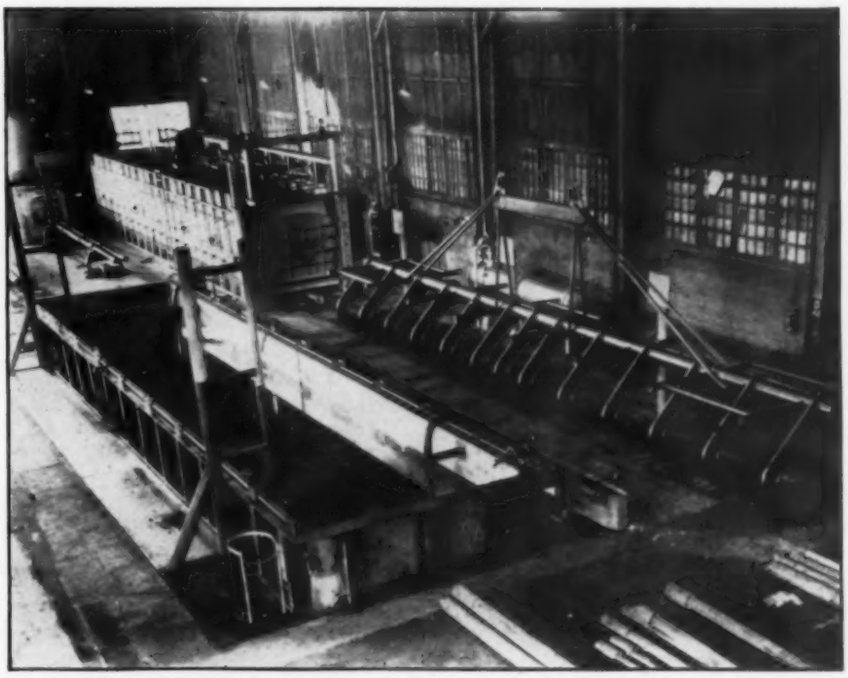
At present, the plant can pour about 100 pounds of metal an hour, with room for expansion to approximately triple this figure.

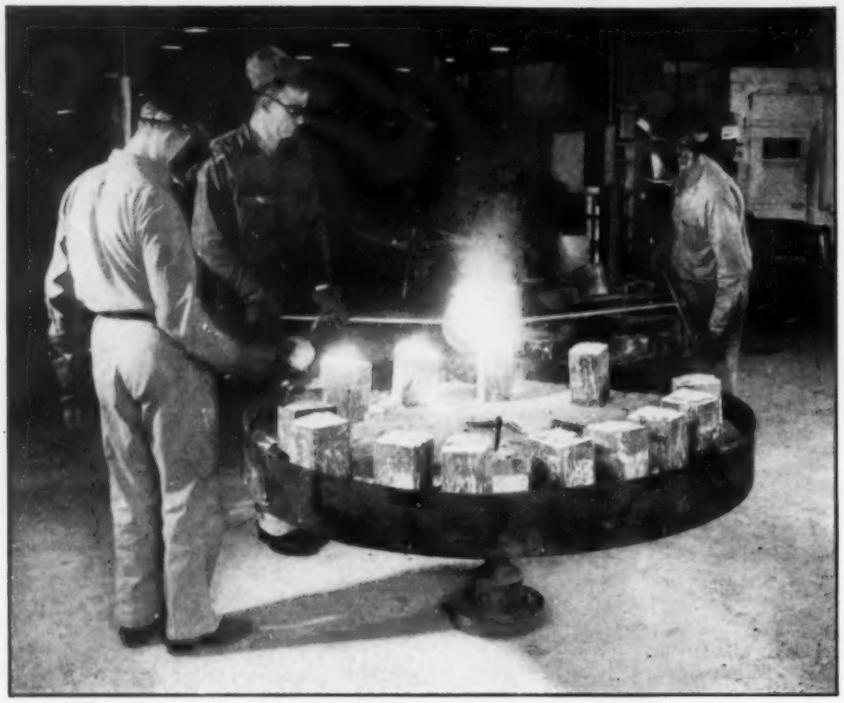
After considerable experiment, Allis-Chalmers has standardized on wax as a pattern material, finding it preferable over present plastics from the standpoint of lower injection pressures and better shrinkage control. Wax is compounded and melted for all machines at a central point just outside the wax pattern room. Also at this station, reclaimed wax is molded into sprue shapes.

Metal is melted in 30 kva, 9600 cycle induction furnaces, each holding about 35 pounds, and is transferred to the molds by ladle. After removal from the oven, flasks are set on a circular pouring table, which can be rotated to bring each flask to the most convenient pouring position. Standard

NEW HEAT-TREATING EQUIPMENT AT SPANG-CHALFANT

New heat-treating equipment at the Ambridge, Pennsylvania, plant of the Spang-Chalfant division of National Supply Company accommodates bars more than 50 ft long. Used exclusively for the manufacture of drill collars, this equipment enables full length heat treatment of this important oil field product 50 per cent longer than had been possible before. In addition, drill collars are more uniformly quenched and hardened, and are straighter than before, thus reducing straightening costs, improving machinability, eliminating internal strains, and in general resulting in a higher quality product.





Large rotary hearth furnace in which lightweight insulating firebrick has been used for the first time in a furnace of its size. The furnace is used to heat billets for piercing in the process of manufacturing seamless tubing. The installation of lightweight instead of heavy firebrick has resulted in fuel economies and saving in time and maintenance.

gravity-head pouring is used almost exclusively, although for certain special designs having very thin sections, vacuum pouring may be used.

After cooling for about five hours, castings are knocked out of the flask by an air hammer. Remaining investment is removed in a Wheelabrator and by sandblasting. The individual pieces are then cut free from the group on a special bandsaw which uses a standard blade, but which operates at very high speeds, and is capable of cutting almost any metal. For unusually thick sections of the harder metals, friction saws are available.

X-RAY THICKNESS GAGE USED AT IRVIN WORKS

▲ A G-E x-ray thickness gage continuously measures the thickness of steel in a hot strip rolling mill at Irvin works of the Carnegie-Illinois Steel Corporation, Dravosburg, Pennsylvania. The gage operates on the principle of x-ray absorption, the beam being directed upward from a position below the hot strip as it comes out of the rolls, and its intensity measured by means of a fluorescent screen and photoelectric cell above the strip. By this means it is possible to measure without contact the thickness of the hot steel strip with an accuracy of plus or minus two per cent.

Heretofore, all gaging of the strip thickness has of necessity been delayed until the strip cooled to a temperature where measurement by a hand-held micrometer was possible. In this period of time a modern high-speed mill may roll six or more tons of steel. Any error in mill setting resulting in an off-gage strip is, therefore, very costly because of the large amount of off-gage material produced before the error can be corrected. The need for equipment to gage continuously the thickness of the strip as it issues from the finishing rolls has been obvious for some time.

By ordinary gaging standards, the conditions under which the thickness measurement must be made are somewhat unusual. In a typical steel mill, the strip may be traveling at speeds of 2000 feet per minute or more out of the finishing stand. As it leaves the rolls it may vibrate vertically through an amplitude of several inches, and to prevent the possibility of jams or "cobbles," the clear opening through the gage should be at least 18 inches high. Ordinarily, the temperature of the strip is between 1100 and 1750 F. Cooling water sprays deluge the strip and any adjacent equipment.

Under these conditions, a successful solution to the problem had to await the development of an effective x-ray gaging technique. The new instrument, developed in General Electric's general engineering and consulting laboratory, employs an x-ray beam passing through the hot strip and falling on a radiation detector which compares the intensity with a standard reference and shows the deviation on an indicator panel. The most difficult problem encountered in the development of the instrument was to stabilize the x-ray beam. This is accomplished by providing a second x-ray beam from the same source, so directed that it falls on a second detector, the output of which controls an electronic voltage regulator in the primary circuit.

Although the new gage is designed to fill a specific need — that of measuring the thickness of hot-rolled steel strip — the method employed is adaptable to many other gaging problems where a non-contacting gage is desired. One such application is the gaging of cold-rolled steel strip where, because of the speed of the strip, the accuracy of contacting methods of gaging is reduced. The method can also be used with metals other than steel, and with various non-metals.

ROCKWELL ADDS RED STAR PRODUCTS

▲ W. F. Rockwell, Jr., president of the Rockwell Manufacturing Company, Pittsburgh, Pennsylvania, announced that Red Star Products, Inc. of Norwalk, Ohio has been purchased through the medium of stock exchange. Details are not announced. This company manufactures light, medium and heavy duty type radial arm saws. The corporate identity of the acquisition is to be continued and the company will operate as a Rockwell subsidiary.

In commenting upon the latest addition to his firm, Mr. Rockwell said that radial saws round out the line of quality wood working machine tools now made by the Delta Manufacturing Division of Milwaukee. Red Star products will be sold through Delta dealers under the brand name "Multiplex."

The headquarters of Red Star Products, Inc. were recently moved

from Cleveland to Norwalk, Ohio. There are now approximately 100 employees working in a modern plant embracing 35,000 square feet of floor area.

Ralph R. Roemer, now president, will remain with the organization in a consulting capacity. Ralph G. Caouette, manager of industrial engineering for all Rockwell properties has been assigned to Norwalk as acting general manager.

This latest acquisition by Rockwell Manufacturing Company brings to a total of 17 the number of subsidiaries and divisions operated by the Pittsburgh organization. The company manufactures a highly diversified line including machine tools, meters, valves, control devices and computing mechanisms.

TONNAGE OXYGEN PLANT BUILT BY DU PONT

▲ A tonnage oxygen producing plant will be built and operated by Linde Air Products Company, a unit of Union Carbide and Carbon Corporation, to supply oxygen to the Belle, West Virginia plant of E. I. du Pont de Nemours and Company. The output of the Linde plant will be 360 tons, or approximately 9,000,000 cu ft a day, of 95 per cent pure oxygen. This will be piped directly from Linde's plant to the du Pont plant under a long-term contractual arrangement. The Linde plant will be located on du Pont property. Construction is expected to be completed sometime in 1949.

About three weeks ago Linde Air Products Company announced an arrangement for erecting a plant to supply tonnage oxygen to the Wheeling Steel Corporation mill at Steubenville, Ohio.

REPUBLIC STEEL RELINES CANTON BLAST FURNACE

▲ A major re-lining and improvement of the Canton blast furnace of Republic Steel Corporation was completed May 14.

The furnace was blown out on April 3 and re-lighted May 14. All told, the work was performed in 41 days and five hours from blow-out to relighting. All fire-brick was torn out and replaced, a carbon hearth installed and a large amount of steel construction undertaken.

Mayor Carl Kline of Canton lit the furnace during a brief ceremony. George W. Putnam, district manager of Republic's Central Alloy district, and Oscar Bamberger, divisional superintendent of the Canton steel plant and furnace division, spoke briefly.

The furnace has a rated capacity of 235,000 tons per year and provides hot metal for Republic's huge alloy steel plant.

REFRACTORY DIRECTORY TO BE REVISED

▲ The American Refractories Institute is preparing to revise the present issue of the "Directory of the Refractories Industry," which was published in 1942. The directory contains information as to the names and addresses of manufacturers of refractories, locations of plants and an alphabetical listing of refractory prod-

A "TOUGH CUSTOMER"

For Open Hearth Service Blaw-Knox Buckets give you ... Rugged strength for hard use ... Speedy operation for quick clean-up ... Safety features that prevent accidents ... Types and sizes to meet your particular needs ... From Catalog No. 2232 you will be able to select the bucket that exactly meets requirements. Write for it today.

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ucts by brand names. The Institute wishes to have the directory cover the entire industry, and while they have contacted all the manufacturers they have any information about, it is possible that there are others who would be interested in being listed in this directory. So in the event that there are refractory companies in the U. S. who desire to have their company listed, they should contact the American Refractories Institute, Railway Exchange Building, St. Louis, Missouri.

FOUR-STAND TANDEM MILL BUILT AT GARY WORKS

▲A huge new four-stand tandem rolling mill went into operation recently at the Gary, Indiana, sheet and tin mill of Carnegie-Illinois Steel Corporation. Construction began last November on the new mill, which is part of the overall modernization and improvement program recently announced for the Chicago-Gary operating district by the U. S. Steel Corporation. Incorporating all the latest improvements, the 54-in. mill is capable of rolling coils up to 48 in. in width and is adaptable for both sheet and tin plate products.

Located in the sheet mill cold reduction department, the new mill is powered by two 9000 hp generator sets and can roll 48,000-lb hot rolled coils into finished gage at a speed of more than one-half mile a minute.

YOU GET BETTER STEEL by this BETTER Modern Method

FURNACE PRESSURE CONTROLLER
Equipped with external manual adjustment for automatically operating stack damper to hold pressure constant.

These Hays Instruments may be used in Combination or Individually.

IN up-to-the-minute open hearth plants you will find an increasing reliance on Hays Pressure Control.

Automatically this simple system regulates furnace conditions --relieves operators of many time-consuming details, gives them more time for more important duties. And Hays instrumentation can be complete or partial.

Here for a fact is "smart business." Better get the facts—write for them, or have a Hays engineer tell you about this better modern method. Representation in all principal cities of the United States and Canada.

PRESSURE INDICATOR
An easy-to-read measurement of furnace pressure. Usually connected at the furnace roof.

PRESSURE RECORDER
A 24-hour record of furnace pressure. Shows timing of reversals and each change of pressure made by the operator during the heat.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

TUBE TESTER USES HYDROSTATIC METHOD

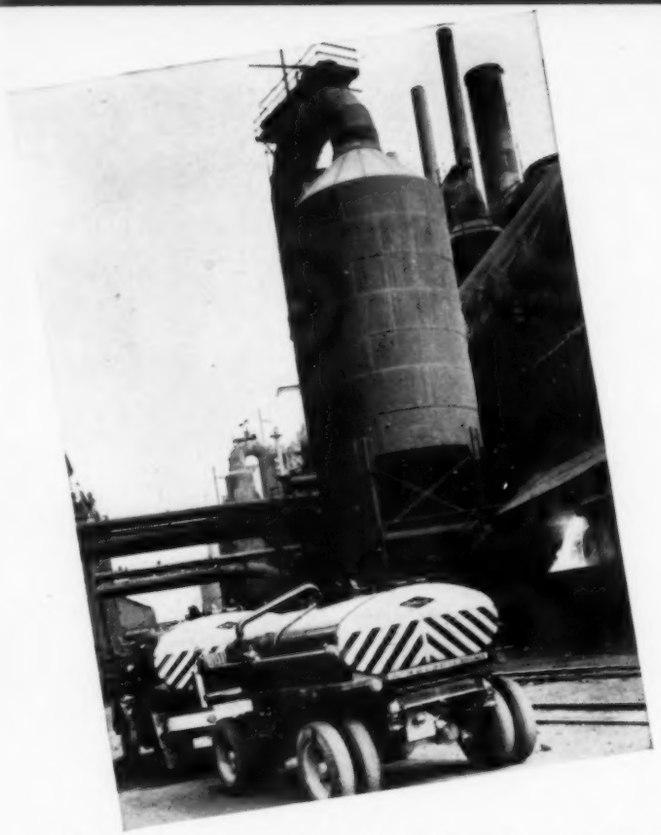
▲The R. D. Wood Company recently announced the completion of a new hydrostatic tube tester. It is designed to test tubes with diameters from ¾ in. to 3½ in. nominal outside diameters, and from 10 ft 0 in. to 26 ft 0 in. in length, at pressures selected and preset from 750 to 3000 lb. The testing of the tubes is conducted with a fluid, usually water, under hydraulic pressure. Average tubes of 3½-in. diameter and 26 ft in length can be tested in 45 seconds or at a rate of 80 an hour.

The machine is essentially a long flat steel bench with steel tension bars along the top of both long sides. These tension bars are drilled so that guides and head can be moved in 6-in. increments to permit the testing of tubes from 10 ft to 26 ft. The tube to be tested is held between two ends or heads, which also seal the tube. The resistance head may be adjusted by means of the drilled holes in the tension bars, while the other head is movable and applies to pressure to the tube. The movable head is arranged for a 12-in. maximum stroke or an 8-in. minimum stroke. A high pressure oil hydraulic operating cylinder delivers the thrust on the movable head and the fluid is also introduced into the tube through a passage in the cylinder. Three clamping carriages spaced between the two heads clamp automatically to hold the tube securely.

In the testing cycle, the tube is first clamped by the air-operated clamping carriages. The movable head moves forward and the tube is forced into the sealing assembly in the movable head. Continued motion forces the tube back till it is sealed in the resistance post assembly. The test pressure is then applied. When the test is completed the cycle is reversed

DOWELL

SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS



Here's how

Chemical Scale Removal Service

SAVES TIME AND MONEY FOR STEEL PLANTS!

Steel plant operators who rely on Dowell for chemical scale removal service for heat-exchange equipment find it quick, effective, safe—and economical. Blast furnace cooling systems, for example, may be cleaned *without shut down*—and real savings result!

Dowell engineers fill the equipment to be cleaned with specially selected liquid solvents designed to dissolve and disintegrate scale and sludge deposits. Dismantling is unnecessary; down time is reduced to a minimum. Every step of the work is planned and carried out by trained Dowell personnel—and Dowell supplies the truck-mounted tanks, pumps, heaters, mixers and control equipment.

Get the *facts*. Call the nearest Dowell office for estimates and full data on chemical cleaning service for:

- Blast furnaces, open hearth furnaces
- Boilers, condensers, economizers, feed water systems
- Engine, compressor and blower jackets
- Rolling mill cooling systems
- Locomotive boilers
- Water wells, water lines and piping
- Coke plants—scrubbers, coolers, precipitators, gas lines
- Building heating, air conditioning, steam and water distribution systems

CALL

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SUBSIDIARY OF THE DOW CHEMICAL COMPANY

New York	Buffalo	Wichita	Mt. Pleasant, Mich.
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Baltimore	Detroit	New Orleans	Salem, Illinois
Wilmington	Chicago	Baton Rouge	Borger, Texas
Richmond	St. Louis	Ft. Worth	Wichita Falls, Tex.
Jacksonville	Kansas City	Shreveport	Lafayette, La.

Long Beach, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

A SERVICE ORGANIZATION

This tube tester is designed to test tubes with diameters from ¾ in. to 3½ in. nominal outside diameter.

and the tube is ejected by the clamping carriages.

The entire operation may be controlled by one man from a control panel which contains indicators and two four-way operating valves. All pumps and associated equipment is self-contained, together with a system for cleaning and reusing the water which drains from tube into pump at end of the testing cycle.

ROLLER BEARING FIRM EXPANDS FACILITIES

▲ Seeking to keep its manufacturing machinery and methods as modern as possible, Timken Roller Bearing Company "plowed back" into the business a total of $1,836,870 in the first four months of 1948.

Largest single expenditure authorized was for the St. Thomas plant, which is to receive a total of $611,910. Of this amount, $301,000 is for a new carburizing and hardening department which is to be housed in a new addition to the plant. Equipment for the department will cost some $291,750. Other expenditures at the unit include the purchase of three 2000-kva transformers for $12,285 and miscellaneous items for $6875.

The addition of carburizing and hardening operations will increase the floor space of the Canadian plant by 17,000 sq ft and require the hiring of some 75 new employees.

Placed in operation in November, 1946, the plant receives hardened cups, cones and rolls from Canton for grinding, inspection and assembling of bearings and employs some 300 persons.

The Canton bearing division — comprised of the Canton and Gambrinus bearing factories — was second in the period's authorization with a total of $396,445.

Of this amount, $44,400 will go for 12 roll-honing machines, $86,000 for tool room equipment to set up special cup production, $34,605 for screw machines for special cup production, $46,300 to lay foundations and piping for the machines, $24,350 for grinding equipment for the special cup production, $27,400 for equipment to be used in making super-precision bearings, $21,100 for improvements in the personnel office building, $14,800 for a cutting-oil installation and $65,500 for miscellaneous items.

The remaining $32,000 will be spent to maintain the high standard of Timken master tools and dies by air-conditioning the tool room.

The Columbus plants were authorized $14,965 for miscellaneous items, the Zanesville plants $4100 for miscellaneous items and the Mount Vernon plant $1500 for miscellaneous items.

A total of $21,900 was authorized to the new plant at Colorado Springs, Colorado, for a new storage building to cost $20,100 and miscellaneous items costing $1800.

Expenditures for the steel and tube division totalled $786,040 for the Canton, Gambrinus and Wooster units.

Equipment included in the authorization was a 70-ton 660 hp diesel-

For the Utmost in Turbine Pump UTILITY AND CAPACITY

PEERLESS Vertical Turbine PUMPS

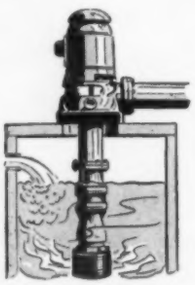
PEERLESS Builds a Pump to Suit Your Service—Capacities: 15 to 30,000 G.P.M.

PEERLESS VERTICAL TURBINE PUMPS FOR DEEP WELL SERVICE

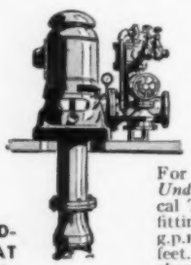
For development of a reliable, permanent water supply, install these deep well pumps with the type of drive most suitable to your application. You have a choice of electric, right angle gear drive, or belted (V- or flat) heads as well as the option of oil or water lubrication. Capacities from 15 to 30,000 g.p.m. are obtained from depths of 1000 feet or more. *Fully described in Peerless Bulletin B-141-1.*

PEERLESS CLOSE-COUPLED TYPE VERTICAL TURBINE PUMPS

For pumping from short settings such as pits, sumps and surface water sources, such as lakes, rivers and ponds, get the full utility and capacity of a deep well pump with a close-coupled Peerless Vertical Turbine Pump. Makes an extremely compact installation. Uses include cooling tower service, boosting, recirculation and dewatering. Capacities: up to 30,000 g.p.m. *Fully described in Bulletin B-159.*



PLAN YOUR PUMP REQUIREMENTS WITH PEERLESS— PEOPLE WHO CARE



PEERLESS VERTICAL TURBINE APPROVED FIRE PUMPS...

For adequate fire protection, the *Underwriters' approved* Peerless Vertical Turbine Fire Pump, with proper fittings, produces from 500 to 2000 g.p.m. against heads from 240 to 285 feet. Built for instant operation. Discharge piping is simplified. Choice of drives and oil or water lubrication. *Fully described in Bulletin B-152.*

DISCOVER ALL THE ADVANCED FEATURES THAT PEERLESS PUMPS OFFER. • REQUEST BULLETINS •

PEERLESS PUMP DIVISION

Food Machinery Corporation

Factories: Los Angeles 31, Calif.; Quincy, Ill.; Indianapolis, Ind. District Offices: New York 5, 37 Wall Street; Chicago 40, 4554 North Broadway; Atlanta Office: Rutland Building, Decatur, Georgia; Dallas 1, Texas; Fresno, Calif.; Los Angeles 31, Calif.

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PEERLESS PUMPS

ONLY COMPLETELY-PROTECTED CONDUCTORS ASSURE *Longest-Lived* WIRES AND CABLES

. . . and only Okolite-Okoprene cables possess these 9 "factors of protection"

With today's installation costs* only the *Longest-Lived* will be economical

* The lifetime cost of a cable rather than its first cost is the only true measure. Okonite wires and cables, built to stand up better and longer, can offset high installation costs.

❶ Conductors are coated with corrosion-resistant Okoloy, a lead alloy that outlasts tinning 2 to 1.

❷ Internal corona cutting is eliminated and dielectric strength increased by Semicon Tape applied over the conductor on all Okolite-Okoprene cables operating at over 2000 volts.

❸ Moisture-resisting, high-voltage Okolite, an oil-base insulation proved in over 20 years of service, is made with Up-River Fine Para, the best grade of natural rubber. Approved as Type RWSN by Underwriters' Laboratories.

❹ The Okoprene covering, a pioneering development of the Okonite laboratories, has established its stability and permanence on millions of feet of cable installed since 1935 under the most severe conditions.

❺ Both insulation and jacket are applied together in a single operation by the strip-process and uniformly vulcanized in a continuous metal mold to give the best and most dependable bond.

❻ Insulation and covering receive but a single vulcanizing "cure" thus eliminating the life-shortening effects of double vulcanization.

❼ Thickness of both insulation and jacket are accurately controlled by the Okonite strip-insulating process.

❽ In addition to a. c. tests, every Okolite-Okoprene cable is subjected to high-voltage d. c. tests more severe than used by any other cable manufacturer.

❾ Okolite-Okoprene cables have the longest and most extensive service record.

Okolite-Okoprene's electrical operating advantages, installation advantages and design advantages are given along with dimensional data in illustrated, information-crammed Bulletin IS-1037. For a copy, please address The Okonite Company, Passaic, New Jersey.

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OKONITE OKONITE SINCE 1878 **insulated wires and cables**

THE BEST CABLE IS YOUR BEST POLICY

"MULTICUT" "TUFCUT" "HOT WORK"

Wapakoneta
SHEAR BLADES
and ROTARY KNIVES

Any type or size blade of proper Alloy with correct hardness and temper for every type shearing machine and every kind of job.

TOOL

Rx ENGINEERED TO THE JOB

Every Wapakoneta blade is made to exact specifications, designed for the particular job. Complete records with order number of each blade makes possible duplication of exact size and temper at any time.

The WAPAKONETA MACHINE CO.
Shear Blade Specialists Since 1891
Wapakoneta, Ohio

electric locomotive for $68,500, steam locomotive improvements for $26,200, equipment for the Canton steel mill's 35-in. mill, $17,630; buildings and construction work at the Wooster plant, $20,960; equipment for the Canton steel mill melt shop, $11,200, and $19,850 for miscellaneous items.

A new 28-in. mill furnace to conserve fuel and increase mill operating efficiency will cost $303,000. A new wire draw and header department in Gambrinus that will cover approximately 50,000 sq ft and will cost $318,700.

WATTHOUR METER HAS MAGNETIC SUSPENSION

▲ A revolutionary new watthour meter that features magnetic suspension of the rotating element has been announced by the meter and instrument divisions of the General Electric Company.

Designated as the Type I-50, the new "floating disk" meter has been designed to give almost a lifetime of trouble-free operation at minimum maintenance costs. A small amount of magnetic material supports all the weight of the disc and shaft, thereby eliminating the need for the jewel

A feature of the new meter is a new damping system.

bearings that have been a major cause for meter maintenance.

The magnetic suspension element consists of two concentric magnets of cunico, a high-coercive material, which have been placed one within the other. The outer magnet is attached to the meter frame, the inner magnet to the upper end of the disk shaft. The interaction of the two magnetic fields supports the rotating

Continental's Progressive Engineering BUILDS TODAY'S FINEST HIGH YIELD Rolling Mills and Equipment

"Progressive Engineering" is Continental's term for a design practice which applies *trained imagination* to the engineering of advanced rolling mills and accessory equipment. Staffed with engineers who have designed and built much of the best high production mill equipment in the country, Continental offers you engineering that uses accepted standards only when proved best—applies advanced principles that give you cost-cutting operations. Even though you have never had a recommendation from Continental before —start *now* to consider Continental one of your logical *first sources!* Many of America's greatest steel and non-ferrous mills are Continental equipped!

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A Few Typical Continental Mill and Equipment Users

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Youngstown Sheet & Tube Co.
Haynes Stellite Co.
Wheeling Steel Corp.
National Steel Corp.
Ford Motor Co.
Sheffield Steel Corp.
Laclede Steel Company
Winchester Repeating Arms Co.,
International-Harvester Co.
Algoma Steel Corp., Ltd.
National Steel Co. of Brazil
American Steel & Wire Co.
Crucible Steel Co. of America
Keystone Steel & Wire Co.

Continental

FOUNDRY & MACHINE CO.

CHICAGO • PITTSBURGH

Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.

system at a small downward displacement. To keep the shaft in vertical alinement, stainless-steel guide pins are located at the top and bottom. Graphite guide bushings at both ends of the shaft run on these guide pins without lubrication.

Another feature of the new meter is a new damping system that consists of two small alnico magnets die-cast into the frame, one on each side of the moving element. These minimize side thrust and the tendency to noise and vibration.

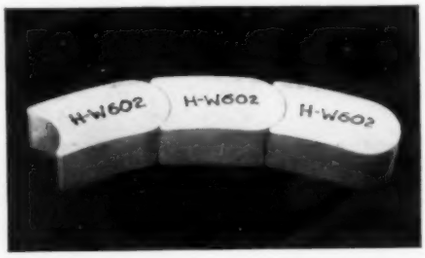
The current coil, with brazed terminals, is molded directly to the core. Butyl rubber, noted for its long-life properties even at high ambient temperatures, provides turn, coil, and ground insulation. The result of this new technique is a securely located current coil that is protected by the rubber from mechanical injury and abrasion. The potential coil, also molded for greater insulation strength, is encased in a polyethylene plastic of high dielectric strength and low moisture absorption. This new electromagnet design assures long life and calibration stability.

Meters of smaller size and lighter weight result from unit construction, another feature of the meter.

REFRACTORY BLOCKS FOR USE IN CUPOLAS

▲ A new design in refractory cupola blocks which permits the setting of a wide range of lining diameters with whole blocks of a single shape is now in production by Harbison-Walker Refractories Company. The range of diameters accommodated by the given shape is reported as from two feet to eight feet and larger, inside diameter, in multiples of three inches.

The new shape, known as the "Universal" cupola block, is of standard 9 in. × 6 in. × 4 in. dimensions but features alternate convex and concave ends which form a highly flexible but tight fitted-curve end joint that maintains a complete contact over the entire end surfaces regardless of the diameter of the lining. In this manner the various lining diameters can be set entirely of whole blocks without cutting. The flexibility of the joint also permits accurate setting in stacks that are warped or slightly out of round. Because of the flexible joint, the new cupola block is recommended for vertical tanks or furnace linings rather than horizontal cylindrical shells.



These new cupola blocks permit the setting of a wide range of lining diameters with whole blocks of a single shape.

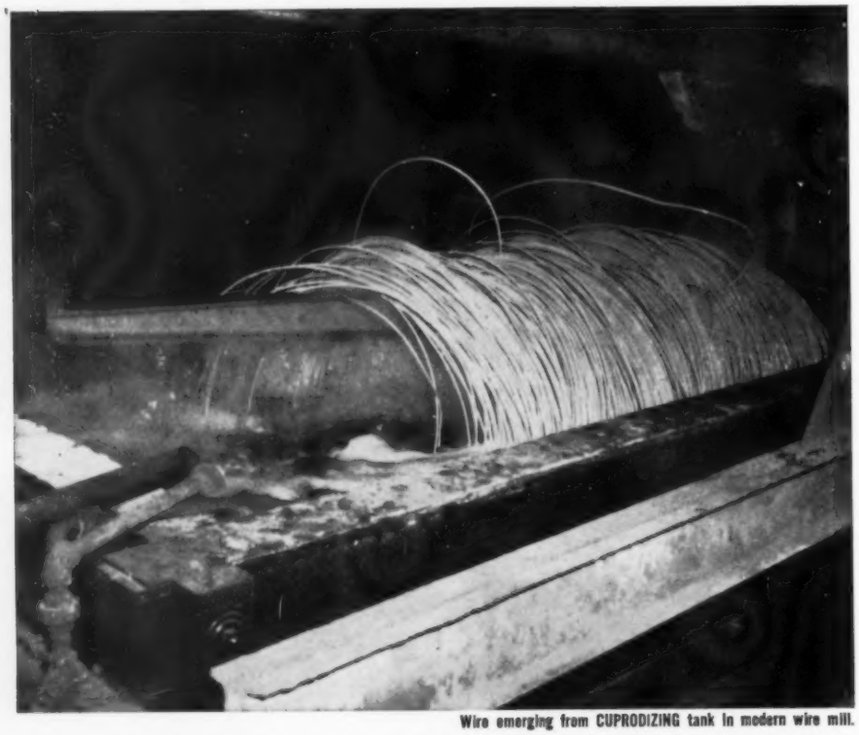
The new blocks are a fireclay product of various blends and burnings to best adapt to particular cupola services. Three sizes provide 4½ in., 6 in. and 9 in. linings to be set.

INSULATING VARNISH FOR GENERAL PURPOSES

▲ A new insulating varnish which possesses the best combination of electrical, mechanical and chemical properties ever attained in a General Electric general purpose varnish has been announced. Designated as G-E general purpose varnish No. 9574, the new material can be used with practically all types of winding including enamel, cotton, asbestos, and glass covered wire.

A thermosetting, phenolic drying-oil varnish, it cures to a tough, pliable mass even in the deepest coils. It gives exceptional resistance to oil, acid, alkali, salt water, moisture, and heat, and is suitable for infra-red baking. Possessing excellent aging properties, the varnish has good build and flexibility, and imparts excellent dielectric strength.

It is stated that the new varnish is



Wire emerging from CUPRODIZING tank in modern wire mill.

CUPRODIZED WIRE INSURES LONGER DIE LIFE AND IMPROVED DRAWING

CUPRODINE is Fast—Efficient—Economical. It Lubricates—Reduces Scratching—Prolongs Die Life—Increases Linear Footage of Drawings per Die—Expedites Uniform Drawing. CUPRODINE is applied by dipping wire into a chemical bath for a few seconds. For passivating CUPRODINE or solid copper surfaces—for bonding paint—CUPROTEK is recommended.

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AMERICAN CHEMICAL PAINT COMPANY

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Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

LORAIN BLAST FURNACE ENLARGED

Pictured at the Lorain, Ohio, plant of National Tube Company, U. S. Steel's pipemaking subsidiary, is a 16-ft blast furnace bell. This bell is for the plant's No. 4 furnace, in background, which is being relined and enlarged to 1300 tons a day capacity. She produced 2,300,000 tons of iron since being built in 1940, set a world's record of 43,866 net tons in May, 1942.

especially easy to work and can be cured in conventional equipment at baking cycles as low as 212 F. It has a flash point of 100 F and its viscosity at 45 F is 600 centipoise average. It is reported that the new insulation varnish can be used at barrel gravity or can be thinned up to 20 per cent with petroleum spirits or any other available commercial thinner.

ARMCO RELINES BLAST FURNACE

▲ Efforts to get a blast furnace back into production quickly because of the great demand for steel resulted in excellent time for relining a blast furnace recently, at the Hamilton, Ohio, plant of Armco Steel Corporation.

The 900-ton, number two blast furnace was rebuilt in the remarkable time of 32 days and 10½ hours from the time the furnace was blown out until the furnace was blown in again.

Relining projects like this one usually require from 45 to 55 days, and must be performed every 3 to 5 years, depending upon the condition of the furnace.

Advance preparations for the work started months before this shutdown of the furnace. Time schedules for every detail of the work were planned and followed closely. Numerous time-saving, unique methods were used in order to speed the furnace back into production.

The furnace was originally built in 1939; has an 18 ft hearth diameter; is 94 ft high. This has been its third relining. Production of nearly 1¼ million tons of pig iron was posted since its last relining in 1944. Last year, an all-time high production record for this furnace was recorded.

LIQUID LEVEL CONTROL HAS REVERSIBLE ACTION

▲ The "Leveltronic" relay for liquid level control, recently introduced by R-S Products Corporation, is now constructed so that direct or reverse action is possible at no extra cost. This feature provides for fail-safe action on line failure, or a tube

(*Please turn to page 122*)

Print up to 2000 feet per minute with the NEW Pannier AUTOMATIC SHEET and STRIP "Master Marker"* ...make complete die change in 30 seconds!

Pannier Engineers, through constant research and experimentation, have successfully developed a marking device for efficiently and automatically printing sheets and strip made from any kind of material.

ANOTHER Pannier FIRST

CHECK THESE MONEY-SAVING ADVANTAGES:

- Prints *all* materials—any thickness.
- Driven by product or conveyor at production-line speed—up to 2000 feet per minute with safety. (Wheel need not ride on product.)
- Complete brass-back die held by spring pin—quickly and easily changed.
- Interchangeable Dovetail National Type for heat numbers, etc.
- One or two dies—any spacing required.
- Felt ink roll with enclosed bearings—inked from face—adjustable to die thickness.
- Adjustable-set-screw-collar crossbar mounting.
- Adjustable die pressure—remains constant despite product irregularities.
- Full counterweight on drive wheel axle for perfect balance.
- Friction drive, Alemite-lubricated-roller-bearing wheel with 30-35,000-mile-life rubber tire.
- Fully guaranteed. **Pat. applied for*

Write for Bulletin ASS-1 which gives detailed specifications and prices. Pannier is a specialist in the design, engineering and manufacture of *all* types of marking equipment. Write us your needs.

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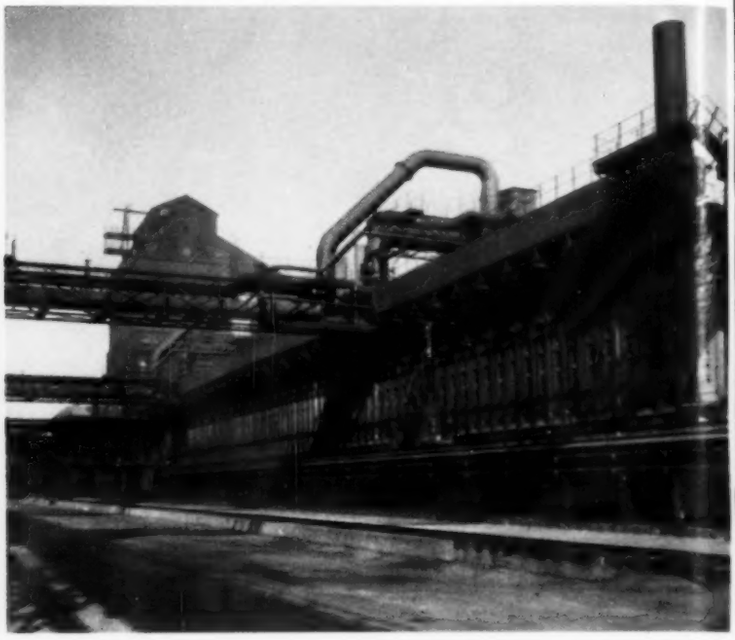
KOPPERS put all these coke oven plants

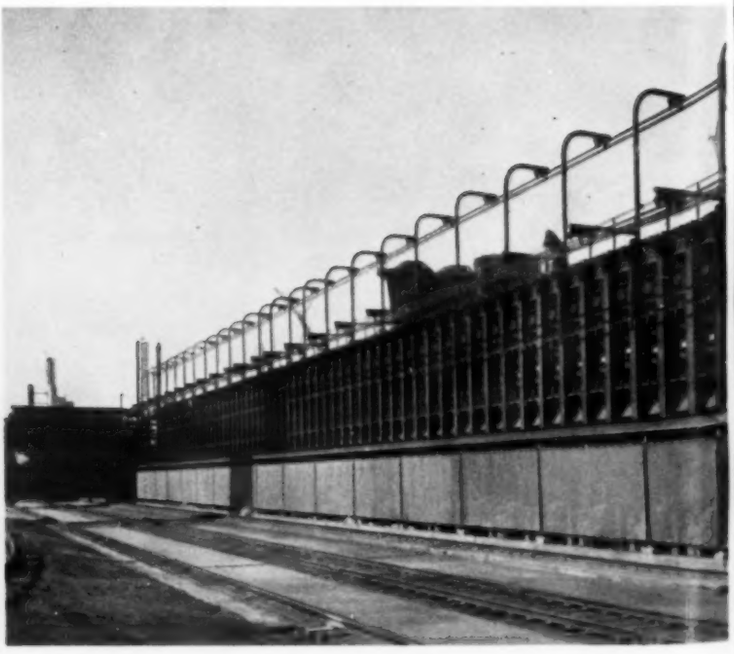
Their annual carbonizing capacity is 3,864,000 tons

SPARROWS POINT, MD. 61 OVENS



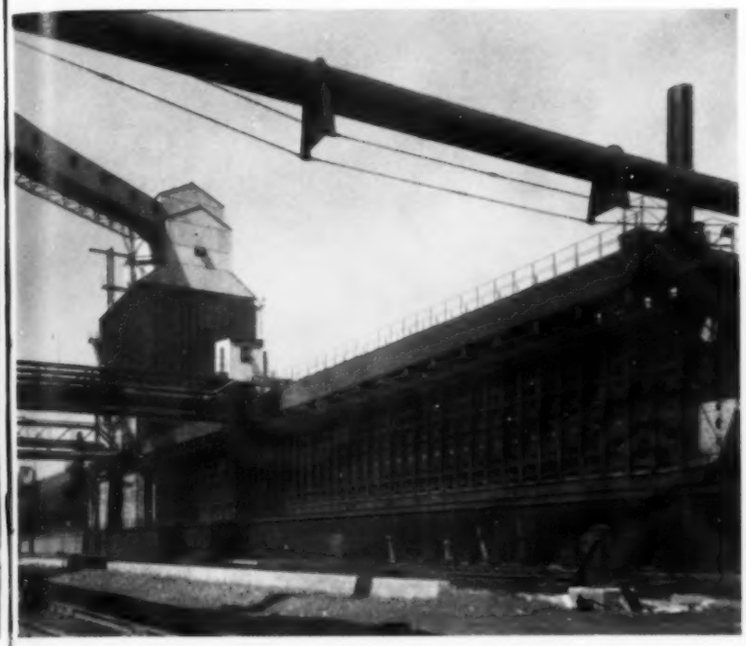
CLAIRTON, PA. 87 OVENS

HAMILTON, OHIO 25 OVENS



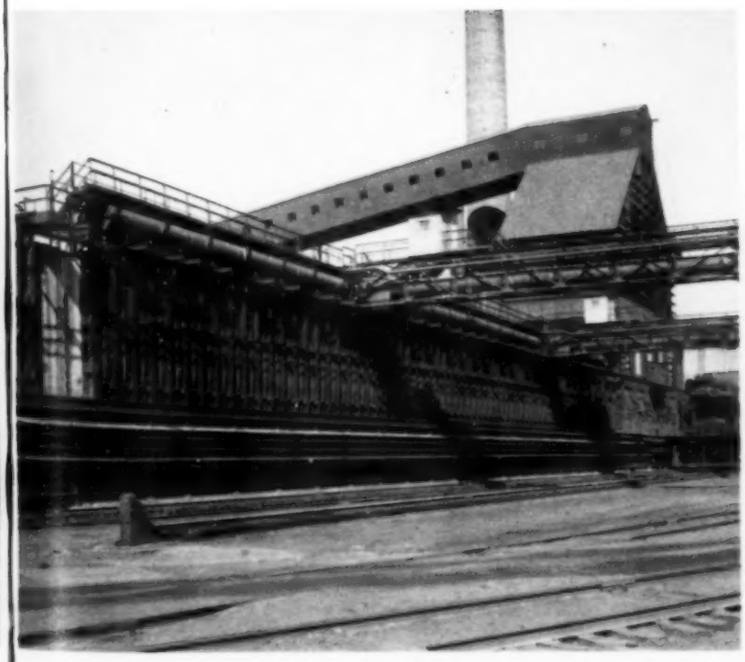
MIDLAND, PA. 21 OVENS

into operation within a period of one year



WEIRTON, W. VA. 106 OVENS

PUEBLO, COLO. 74 OVENS



FAIRFIELD, ALA. 63 OVENS

MONTREAL, QUE. 15 OVENS

KOPPERS

KOPPERS COMPANY, INC.

ENGINEERING & CONSTRUCTION DIVISION

PITTSBURGH 19, PA.

(*Continued from page 119*)

becoming inoperative, the company says, thereby protecting against overflow or underfilling of process units. Out-contacts on the relay may be used to sound an alarm, light a signal light, or shut the process down.

The change from one type of action to the other can be accomplished by any competent instrument man, according to the announcement, using only pliers and soldering iron. No extra parts or unusual skill is necessary.

NEW WELDING MACHINE HAS STEADY CURRENT

▲ Air Reduction Sales Company announces the availability of the new Wilson "Wasp Special" air cooled, engine driven, arc welding machine. The new welding machine is designed to furnish a smooth steady current and to stand up under usual and regular duty factor load conditions in tough construction and maintenance jobs in many varied applications.

This new 200 ampere arc welder has a welding range of 25 to 250 amperes at 30 volts, 50 per cent duty cycle. It is a light weight machine that is easy to handle and ideal for work in places inaccessible to larger and heavier equipment. Two convenient outlets are provided which may be used for lighting purposes or to operate universal power tools in an emergency.

MARKING MACHINE FIRM ADOPTS NEW NAME

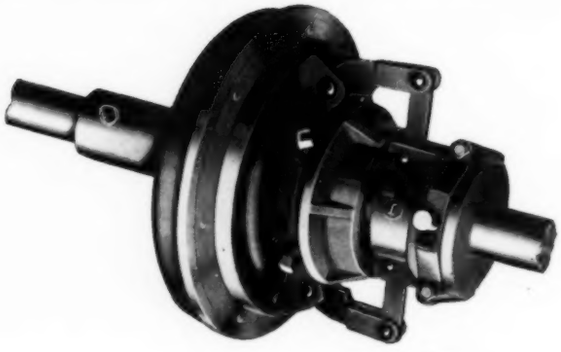
▲ The incorporation of the former Pannier Brothers Stamp Company, 207-209 Sandusky Street, Pittsburgh 12, Pennsylvania, under the new name, The Pannier Corporation, has been announced by company management. This change is one of name only. It does not involve any change in the firm's structure, its personnel, its policies, or any of its activities in the design, engineering and manufacture of all types of marking equipment for industry. The new corporation still retains the Pannier "Master Marker" trade mark which it has used since shortly after the original company was founded in 1899.

Sheet and strip marking up to 2000 fpm and a complete die change in 30 seconds are possible with a new "Master Marker" automatic printing machine recently announced by Pannier Corporation.

The new marking device prints all materials of any thickness. Mounted and positioned on an overhead crossbar by adjustable set-screw collars,

Sheet and strip marking is possible at speeds up to 2000 fpm with this marking machine.

JONES-LEMLEY FRICTION CLUTCHES



JONES-LEMLEY friction clutches are built for a broad range of shaft sizes and ratings in both enclosed and open types for sleeve and coupling work. In addition they are available in a line of Jones-Lemley friction clutch pulleys. This clutch modification is also used for gears, V-belt sheaves, sprocket wheels, etc. Sizes, ratings, dimensions, prices and other data are contained in Bulletin No. 60. Your request will bring a copy.

W. A. JONES FOUNDRY & MACHINE CO., 4431 Roosevelt Rd., Chicago, Illinois

Jones

HERRINGBONE — WORM — SPUR — GEAR SPEED REDUCERS • PULLEYS
CUT AND MOLDED TOOTH GEARS • V-BELT SHEAVES • ANTI-FRICTION
PILLOW BLOCKS • FRICTION CLUTCHES • TRANSMISSION APPLIANCES

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NEW FLEXIBILITY

with the RELIANCE

GEARMOTOR

Any type enclosure of Reliance A-c. or D-c. Flange-mounted *Precision-Built* Motor may be chosen. A full selection of speeds from 4 to 1,430 rpm. is offered with motor ratings from 1 to 60 hp. For details of the many advances in design behind the superior performance of this sturdy, compactly constructed Reliance GearMotoR, write today for Bulletin C-404.

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Built by RELIANCE ELECTRIC & ENGINEERING COMPANY and PHILADELPHIA GEAR WORKS, INCORPORATED

RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"

it is motivated by a friction-drive lubricated roller bearing wheel with a 30-35,000-mile-life rubber tire. The wheel is driven by either the product or conveyor (wheel need not ride on product) at production speed. A full counterweight is mounted on the wheel axle for perfect balance.

The new machine retains the Pannier brass-back dies used in all such equipment since 1936. The complete die is held by a simple spring pin for quick and easy changing with little loss of production time. One or two dies may be used — at any spacing required. Die pressure is adjustable and remains constant despite product irregularities. The felt ink roll has enclosed bearings, is inked from the face, and is adjustable to die thickness.

SHOVEL ATTACHMENT FOR FORK TRUCKS

▲ Chief among several improvements which feature a new type of fork truck shovel attachment announced by Clark Tructractor division of Clark Equipment Company, is a pneumatic snubber which minimizes the shock and strain to the upright assembly when the load is discharged.

In addition to the snubber, the shovel has 3-point suspension, with a roller cam lock and a single point hook, which permits release of any load with a 15-lb pull.

The shovel is ruggedly built of ¼-in. steel plate; with a blade 6 in. wide, of specially hardened steel and flame hardened edge. The blade is welded to the bucket. The unit was specially designed for fork truck use in confined areas and for general factory service. It is readily interchangeable with forks and all other attachments mounted directly to the standard fork bars on Clark fork trucks. It is available for use on most models of Clark fork trucks.

The unit was designed for operation in confined areas.

COAL CAR DUMPER DUMPS CAR-A-MINUTE

▲ The Heyl and Patterson electrically operated high lift turnover coal car dumper is capable of picking up coal cars up to 120-ton capacity, elevating them 75 ft, turning them over and discharging their contents into the hold of a vessel at the rate of a car-a-minute.

Two-way voice-radio communication of the FN type has been provided to assure complete coordination between the supervisor of the car dumper, the barney operator, the cradle operator, the tower operator and the operators of the electric pusher locomotives. In addition, telephone communication is provided between all operating points.

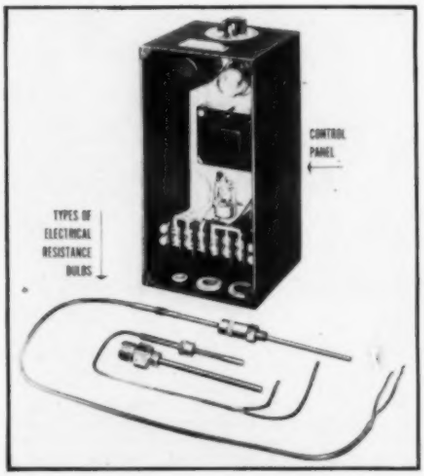
The apparent ease of operation of this giant machine is the result of Heyl and Patterson's continuing efforts through 60 years to build each succeeding piece of heavy bulk materials handling equipment better than the last.

The operation of the car dumper is controlled electrically by a crew consisting of three operators on the dumper, the pusher locomotive operators and the car retarder and switching operator. They control a total of 20 motors, ranging from 15 to 500 hp and amounting to more than 3000 hp. The power for the d-c drives is supplied by two motor generator sets located in the substation adjacent to the dumper, each consisting of a 1400 hp, a-c motor drive, two 450 kw and one 375 kw generators.

Twelve hundred tons of structural steel, 600 tons of machinery, a mile and a quarter of wire rope, ⅝ in. to 1¾ in., and over 200,000 man-hours of engineering and labor went into the design, fabrication and erection of this coal car dumper.

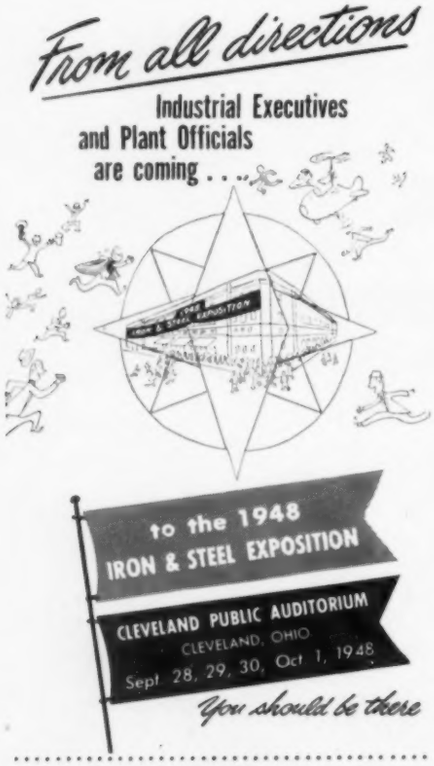
TEMPERATURE CONTROLLER USES SINGLE TUBE

▲ A temperature controller, said to be simple, fast, and precise, has been developed by the instrument division of Thomas A. Edison, Incorporated. The device uses a single electronic tube with an electrical resistance type bulb for thermal pick-up and is of the on-off type.



The device uses a single electronic tube with an electrical resistance type bulb for thermal pick-up.

The use of the resistance bulb permits location of the sensing element at a point remote from the control panel and eliminates the necessity of thermal compensation. This device, which is non-indicating, may be used



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IN STRENGTH

1ST

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IT'S

Alliance . . .

THE LARGEST CRANE IN THE WORLD!

Talk about giants—you should see this huge Alliance crane spanning the Navy's mole at Hunter's Point, California. It's the world's largest crane, and is so big and powerful that it can easily pick up a 500-ton battleship gun turret!

This rugged crane with the amazing precision control is so large that it has its own electric sub-station, aerial beacons to warn aircraft away, and a short-wave radio for communication between the operating crews.

The bridge span of the crane is 142 feet center to center of rails, and the span of the trolley is 20 feet. Its two cantilevers extend 162½ feet out over the water on each side of its specially-built pier.

Of course, Alliance builds smaller cranes, too . . . all sizes, in fact, to help move heavy loads quickly, safely, and easily.

Always depend on Alliance to give your plant the economical, extra lifting power you need.

- LADLE CRANES
- GANTRY CRANES
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- SOAKING PIT CRANES
- FORGING MANIPULATORS
- OPEN HEARTH CHARGING MACHINES
- SLAB AND BILLET CHARGING MACHINES
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THE ALLIANCE MACHINE CO.

Main Office
ALLIANCE, OHIO

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to control temperatures to close tolerances in solids, gases, or liquids. Units are available to cover the temperature range from —100 F to 1200 F and are adjustable within a range of several hundred degrees.

Supply voltage may be 115 or 230 volts 50-60 cycle alternating current. Load capacity is 30 amperes at 115 volts, 20 amperes at 230 volts. Accuracy of the controller is independent of usual voltage variation. Normal response time is under three seconds, due to the patented bulb construction.

A 5 in. × 5 in. × 10 in. control panel, weighing less than 8 lb, complete, is furnished and is provided with conduit knockouts and a rugged terminal board. This may be located at any convenient place and at considerable distance from the temperature zone.

FUSE COMPANY ADOPTS NEW FIRM NAME

▲ Ware "Hi-Lag" fuses formerly manufactured and sold under the firm name of Ware Brothers are now being sold under the new corporate name of Ware Fuse Corporation, 4450 W. Lake Street, Chicago 24, Illinois. Operations will continue under the same management as heretofore.

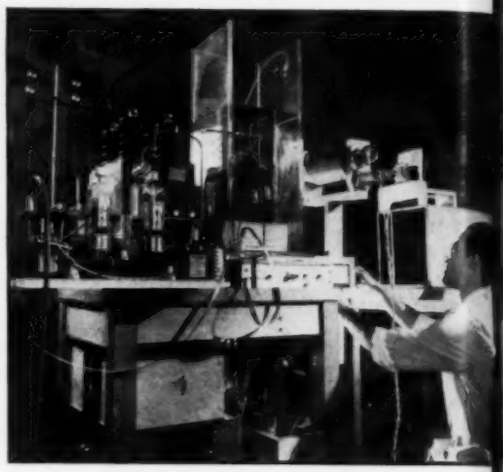
Ware Fuse Corporation now has representatives in 14 major markets. The names of the representatives are as follows: Kenneth Anderson Company, 412 Seaton Street, Los Angeles; Hodges and Glomb, 1264 Folsom Street, San Francisco; Industrial Products Company, 534 First Avenue Pittsburgh; M. B. Urguhart, 16th Street at Blake, Denver; Electrical and Steel Sales Company, Inc., 241 East Erie Street, Milwaukee; E. B. Rouzer, 840 Plymouth Building Minneapolis; Henri Duizend, 308 Balter Building, New Orleans; R. J. Milford and Son, 100 Warren Street, New York; Thos. J. Fleischer, 333 Candler Building, Atlanta; C. C. Pierce Company, 241 Purchast Street, Boston; A. Weingarten, 734 Bainbridge Street, Philadelphia; Anchor Sales Company, 1901 Gravois Avenue, St. Louis; Electronic Specialty Representatives, P. O. Box 5125, Portland; and Howard H. Loving, 53 W. Jackson Boulevard, Chicago.

X-RAY EYE ANALYZES MOVING OBJECTS

▲ Development of super-speed x-ray motion pictures, opening fascinating new visual worlds to science, was recently disclosed to the American Physical Society in Washington, D. C.

"This x-ray 'eye' can analyze the internal structure of rapidly moving

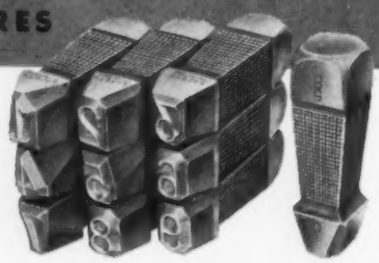
The new technique may solve how metal is deposited from an arc welding rod.



For Maximum Safety in Stamping—

"SAFETY" Wedge Grip

STEEL LETTERS AND FIGURES



- No mushroom
- No spall
- 25% to 50% more service
- More Safety!
- Pat. No. 2,089,794

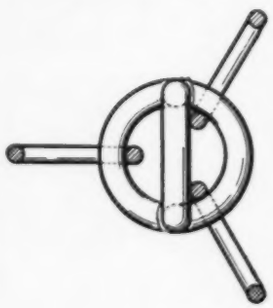
Perfect balance . . . Knurled sides not only assure *positive* grip with "Wedge Grip" to give clearer, deeper impressions—but also lessen severity of extra heavy stamping. Characters available from 1/16" to 1"

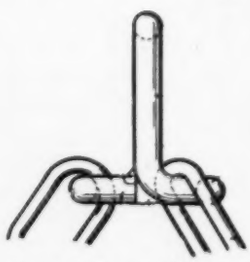
Write for Bulletin J-547

M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS

105 E. Carson Street Pittsburgh 19, Pa.

LONG LIVED
Frictionless
Magnet Suspension Chains





Suspension Chains for 55" and 65" Lifting Magnets that eliminate friction, so will last 4 times as long as old-fashioned Suspensions because:

1st: Each leg hangs free on ring and in magnet ears with no twisting or rubbing.

2nd: Suspension is made of high alloy steel — **heat-treated:** periodic annealing not necessary.

3rd: Each 55" Suspension is tested to 85,000 pounds; each 65" Suspension is tested to 115,000 pounds.

Prompt shipment from stock.

Patent Applied For

DOWNTOWN COMPANY
1836 Euclid Avenue CLEVELAND 15, OHIO

are you ready for the harvest!

Signs point to a continued high demand for rolling mill products. A modern, efficient, high speed Morgan mill will help you capitalize to the full on this demand. It takes time to build a mill. Let's start planning now.

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS
Rolling Mills - Morgoil Bearings - Wire Mills
Regenerative Furnace Control - Air Ejectors
English Representative: International Construction Co.
56 Kingsway, London, W. C. 2, England

RM-18

How you can CUT GRINDING COST AND IMPROVE ROLL FINISH *simultaneously*

Reports from users indicate that with the latest type Farrel Heavy Duty Roll Grinder they are able to cut roll grinding time substantially. At the same time, they obtain rolls with a perfect surface free from marks of any kind, either straight or with concave or convex contours ground to exact symmetry and accuracy. Faster grinding means increased productive capacity of the machine and lower labor cost per roll ground.

In addition, rolls ground by Farrel Heavy Duty Roll Grinders have longer life because the exceptionally smooth and vibration-free action in roll, wheel and traverse drives means less metal has to be removed to clean up a roll in roughing and finishing operations. This is a vital factor in reducing the frequency of roll replacement and, consequently, the cost of new rolls.

This *NEW*, 28-page bulletin shows in text, photographs and diagrams how the performance of these machines is achieved. Features described in detail include: Automatic crowning and concaving device . . . long-wearing inverted V carriage ways . . . smooth headstock drive by adjustable speed motor through multiple V belts . . . automatic lubrication of all vital moving parts . . . vibrationless carriage traverse . . . centralized control of entire grinding operation.

Write for your *FREE* copy of Bulletin No. 115.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston

FB-457

Farrel-Birmingham

1848 FARREL CENTENNIAL 1948

objects and human organs," Dr. Charles M. Slack, director of research for the Westinghouse lamp division, said. "The new procedure brings to x-ray analysis the same advantages slow-motion movies bring to sports events," he added.

Super-speed x-ray movies, developed in the Westinghouse Lamp Research Laboratories in Bloomfield, New Jersey, team up x-ray exposures of 10 millionths of a second and a shutterless camera shooting movies at 100 frames a second. The x-ray exposures, repeated at one-hundredth of a second intervals, are recorded on a continuously moving strip of regular movie film.

In industry, the new technique may solve at last many of the mysteries of how metal is deposited from an arc welding rod, and of how molten metal flows into a casting mold. X-rays, Dr. Slack explained, are unaffected by the strong light and fumes which obscure the conventional motion pictures made in visible light.

The exposures in rapid-fire order after one-hundredth-of-a-second pauses to recharge the equipment powering the x-ray unit.

The electronic tube used to make the exposures at such super speeds handles power pulses exceeding five million watts, 1000 times greater than that handled by x-ray tubes in most physicians' offices. A pulse transformer, similar to that used in radar sets, steps up a 20,000 volt condenser discharge unit to the 150,000 volts required to flash the tube and make the exposure.

Book Reviews

▲ The fifth edition of "Fan Engineering," edited by Richard D. Madison, has just been published. This book has long been regarded as the "Bible" of the air-handling industry. First published in 1941, the four succeeding editions have found increasing use. The book is an engineering handbook on air, its movement and distribution in air conditioning, combustion, conveying, and other applications employing fans. The book is sold at cost by the Buffalo Forge Company, Buffalo, New York, price $6.00, 808 pages 4½ × 7 in., flexible binding.

▲ The second edition of "Modern Metallurgy for Engineers," by Frank T. Sisco, has just been published by the Pitman Publishing Corporation, 2 West 45th Street, New York 19, New York. Cloth bound, 499 pages, price — $5.00. This book is a revised, enlarged edition of one which, since its introduction in 1941, has seen wide adoption as a standard textbook in many universities and as a standard in metallurgical and engineering offices. The book includes the war time developments which resulted due to stimulation of research in the past war. This book emphasizes the hardenability of steel, isothermal transformations and discusses data on these fields which give a much clearer picture than ever before of the structural changes in carbon and low alloy steels caused by heat treatment and of the relationship of structure to engineering properties. The book covers primarily ferrous alloys and a portion of it is also devoted to nonferrous metallurgy.

CRANE BUILDERS Since 1903

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Capacities 5 to 150 Tons

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Provides a Method of Burning Small Quantities of Heavy Fuel Oil at Each Burner

The atomizer operates on high pressure steam. It atomizes a reasonable quantity of oil and then divides and distributes this quantity into equal parts, which are delivered to a number of small burners.

An easy system to control. A workable method for a combination oil/gas application to small gas burners. Suitable for oil application to burners requiring 1½ to 3 g.p.h.

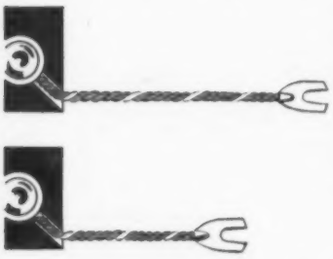
BLOOM ENGINEERING CO.

857 W. North Avenue Pittsburgh 12, Pa.

To Reduce carbon brush inventory with "National" brushes!

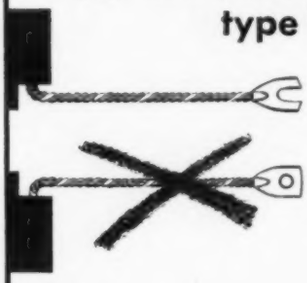
The lack of standardized specifications has always been the bugaboo of carbon brush applications. Here are ways to simplify these specifications and reduce your inventory.

1. Use only two shunt lengths.



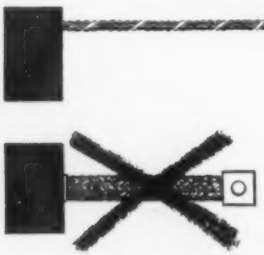
Why specify so many different shunt lengths for identical brushes used on different types of motors and generators? Experience shows that only two shunt lengths—3½ and 5½ inches—are necessary.

2. Substitute slot- for hole-type terminals.



Slot-type terminals are easier to attach to terminal screw. Standardize on the slot-type and you further reduce brush inventories.

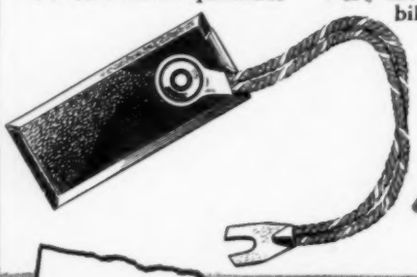
3. Use stranded instead of braided cable.



Stranded cable is suitable for any type connection. Braided cable is not suitable for Q-type connections. By standardizing on stranded cable, you gain further inventory reduction.

HOW BRUSH STANDARDIZATION PAYS—

1. Permits buying in economical quantities
2. Fewer small orders—with savings in bookkeeping, billing, and accounting
3. Less money and space tied up in brush stocks
4. Less time needed to handle stock



The term "National" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

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UCC

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Why carry hundreds of special carbon brush sizes and types when a few standard brushes will do the job as well?

Personnel News . . . .

H. F. Dobscha was appointed assistant district manager of the Cleveland district of Republic Steel Corporation. Mr. Dobscha will succeed the late **J. H. Slater** as assistant district manager and also as chairman of Republic Steel Corporation's blast furnace committee. This committee has general supervision over the operation of the corporation's 21 blast furnaces and is composed of the blast furnace superintendents from Republic's operations in Cleveland, Warren, Youngstown, Massillon, Canton, Buffalo, Chicago, Troy, New York, and Birmingham and Gadsden, Alabama.

H. F. DOBSCHA

Mr. Dobscha comes to Cleveland from Carnegie-Illinois Steel Corporation where he was superintendent of blast furnaces at the Edgar Thomson works at Braddock, Pennsylvania.

Luke E. Sawyer has been elected executive vice president and a director of Babcock and Wilcox Tube Company at a recent meeting of the board of directors. Mr. Sawyer takes over the major management responsibilities in the company following the recent death of Peter D. White, former president. **Paul J. Utnehmer** was named works manager in charge of manufacturing at the Beaver Falls, Pennsylvania, and Alliance, Ohio, plants of the company, and **E. A. Livingstone,** vice president of the tube company, was elected to the board of directors.

Alfred Iddles, president of Babcock and Wilcox Company, the parent organization, was also elected president of Babcock and Wilcox Tube Company.

F. W. Bremmer has been named works manager of the Ambridge, Pennsylvania, plant of National Supply Company. He succeeds **W. M. Frame,** resigned. Mr. Bremmer was formerly works manager of the Etna, Pennsylvania, plant.

Harold R. Beachler was appointed works manager of the National Supply Company's Etna, Pennsylvania, plant. Mr. Beachler has been superintendent of the lapweld mills at Etna.

Curtis A. Gordon has been named general works manager of Jessop Steel Company, Washington, Pennsylvania. Mr. Gordon was formerly superintendent at the Colorado Fuel and Iron Corporation, Wickwire-Spencer Steel division, Buffalo, New York. He has had long and varied experience in the steel industry, being associated with many steel companies; namely, Bethlehem Steel Company, Canton Alloy Company, Donner Steel Company, Rustless Iron and Steel Corporation, and the Crucible Steel Company of America.

W. J. Creighton has retired after nearly 48 years of active service with Jones and Laughlin Steel Corporation. Mr. Creighton was first employed as a clerk in

W. R. HOUGH

CORRECTION

Correcting an error that occurred in the May issue of Iron and Steel Engineer, we wish to announce that the gentleman to the left is W. R. Hough (pronounced how), who was elected engineering vice president of Reliance Electric and Engineering Company. The gentleman to the right, whose picture was used in May by mistake, is R. E. Hough (pronounced huff), general manager, Bethlehem Steel Company, Johnstown, Pennsylvania. We don't know Hough this occurred, but we are very glad to report that these gentlemen are not in a Hough about it.

R. E. HOUGH

DE LAVAL GEAR REDUCERS *in* STOCK

CRATED FOR IMMEDIATE SHIPMENT

WG-22

These popular units are assembled, crated and ready for immediate shipment.

Reducer	*Ratio*	*Probable *HP Motor*	*Reducer*	*Ratio*	*Probable *HP Motor*
BW400	9⅔	5	BW600	11⅔	10
BW400	19½	3	BW600	19½	7.5
BW400	25	2	BW600	25	5
BW400	40	1.5	BW600	40	3
BW500	11⅔	7.5	BW700	9⅔	15
BW500	19½	5	BW700	19½	10
BW500	25	3	BW700	25	7.5
BW500	60	1.5	BW700	40	5

** Based on 1750 rpm—A.G.M.A. Class 1 Service. For other rpm's or Service refer to De Laval rating tables.*

Other sizes and ratios, in both single and double reductions, and in vertical and horizontal drives, also can be furnished promptly.

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Detroit, Mich. Madison 0950
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the accounting department of Jones and Laughlin, Ltd., on August 8, 1900, when he was 18 years of age. After serving as assistant auditor of the raw materials subsidiaries, he was appointed assistant auditor of Jones

W. J. CREIGHTON

and Laughlin Steel Company in 1910. He was appointed auditor of the company in 1911, and in 1918 he was elected controller. Mr. Creighton continued to hold that office until he was elected a director and vice president in 1928. He was also elected to the executive committee in 1928. In 1944, he was elected executive vice president; and in 1947, he was appointed consultant to the chairman of the board of directors.

Charles H. Halford was named export sales manager for Harbison-Walker Refractories Company with headquarters in New York. Associated with Harbison-Walker since 1933, Mr. Halford served in the sales

CHARLES H. HALFORD

departments of both the Cleveland and Buffalo offices. He has acted as assistant export sales manager since 1947 when he was transferred to the New York office.

William Waldron, formerly assistant superintendent of maintenance at National Tube Company, McKeesport, Pennsylvania, was appointed superintendent of the seamless tube mill at National Tube Company, Lorain, Ohio.

James W. Orton has been appointed district manager for Clark Controller Company in Cincinnati, Ohio. Mr. Orton was formerly located in Gary, Indiana.

Three men were awarded the American Iron and Steel Institute Medal at the 56th General Meeting of the Institute on May 26 in the Waldorf-Astoria, New York City. One of the medals was awarded posthumously.

J. L. Mauthe, vice president, Youngstown Sheet and Tube Company, and **Karl L. Fetters,** special

J. L. MAUTHE

metallurgist, Youngstown Sheet and Tube Company, were two of the men honored. Their winning technical paper presented at the Institute meeting in 1947, was titled "The Mineralogy of Basic Open Hearth Slags."

The award for the third winner, the late **J. H. Slater** who was assistant district manager, Cleveland district, Republic Steel Corporation at the time of his death, was received by his two sons, **Joseph L. Slater** and **William A. Slater.**

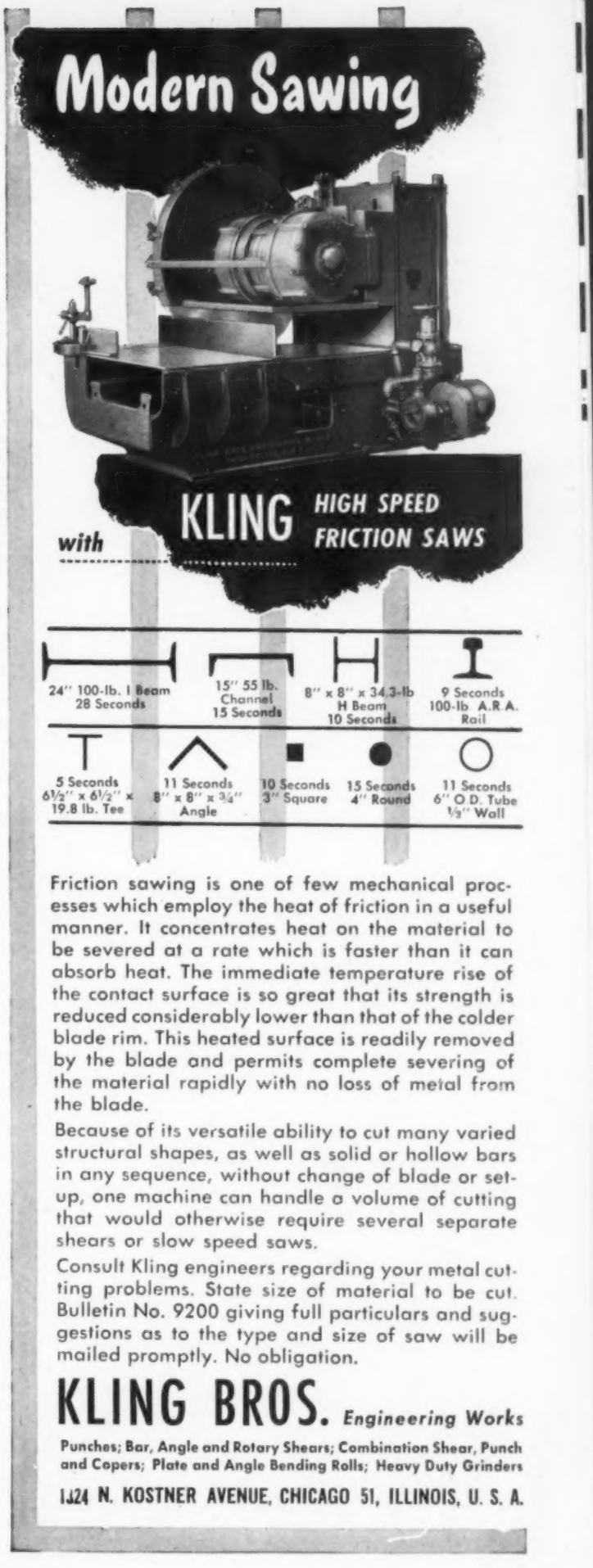
Mr. Slater's medal-winning paper, presented at the Institute meeting in 1947 was titled "Operation of the Iron Blast Furnace at High Pressure."

The Institute Medal, established in 1927 to perpetuate the memory of the late **Elbert H. Gary,** founder and first president of the Institute, is awarded for papers read before the Institute having special merit and importance in connection with the activities and interests of the iron and steel industry.

N. S. Spencer has been named application manager for I-T-E Circuit Breaker Company's Chicago district office. He succeeds **Maxwell L. Sloughton** who has been transferred to Philadelphia.

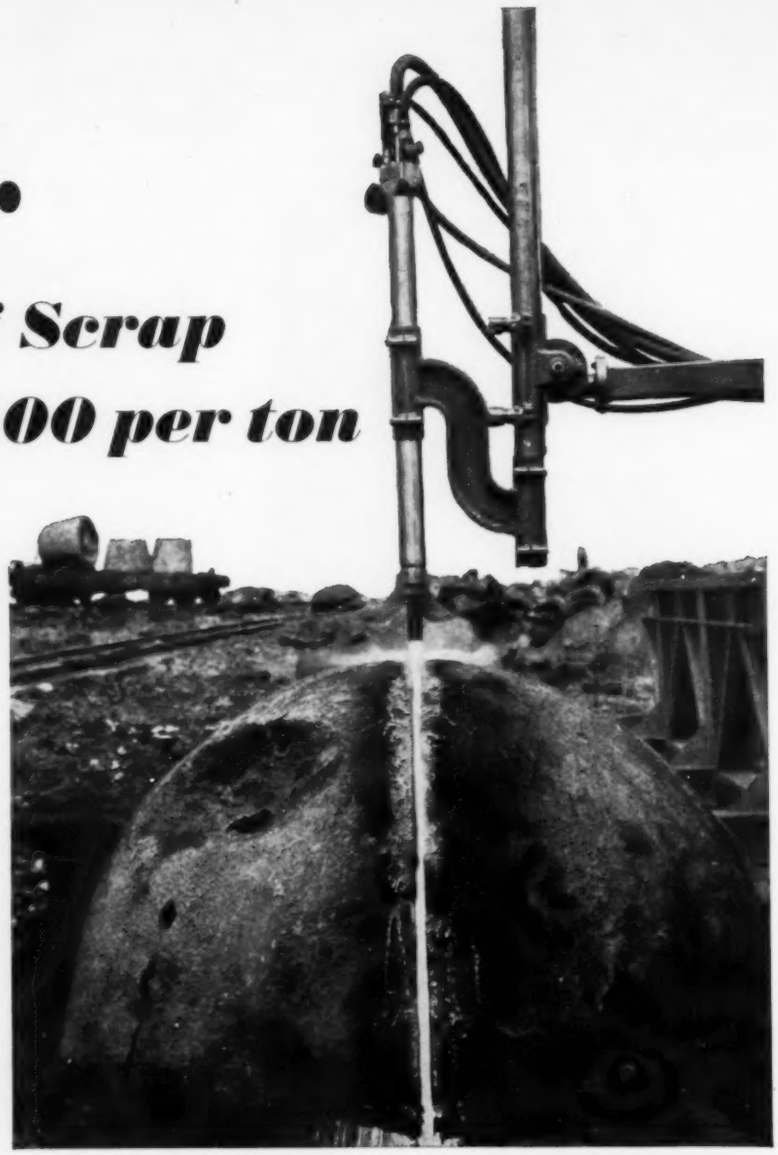
Daniel A. Bryan was appointed superintendent, general service and transportation, at Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania. Mr. Bryan was educated at Mt. Union College, Alliance, Ohio, and at Notre Dame University, South Bend, Indiana. Mr. Bryan started his career in 1932 with Blair and Mack, a contracting firm in McKeesport, Pennsylvania. In June, 1937, he went to work at Carnegie-Illinois Steel Corporation's Irvin works as a chain man. In February, 1942, he became a transit man at the Duquesne, Pennsylvania, works. In July of 1943, he became assistant to the superintendent, general service and transportation, and in December, 1946, advanced to assistant superintendent, which position he held until his present promotion.

William P. Yurik was named assistant superintendent, general service and transportation, at Carnegie-


Modern Sawing
with
KLING HIGH SPEED FRICTION SAWS
24" 100-lb. I Beam 28 Seconds
15" 55 lb. Channel 15 Seconds
8" x 8" x 34.3-lb H Beam 10 Seconds
9 Seconds 100-lb A.R.A. Rail
5 Seconds 6½" x 6½" x 19.8 lb. Tee
11 Seconds 8" x 8" x ¾" Angle
10 Seconds 3" Square
15 Seconds 4" Round
11 Seconds 6" O.D. Tube ½" Wall
Friction sawing is one of few mechanical processes which employ the heat of friction in a useful manner. It concentrates heat on the material to be severed at a rate which is faster than it can absorb heat. The immediate temperature rise of the contact surface is so great that its strength is reduced considerably lower than that of the colder blade rim. This heated surface is readily removed by the blade and permits complete severing of the material rapidly with no loss of metal from the blade.
Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or set-up, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.
Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.
KLING BROS. Engineering Works
Punches; Bar, Angle and Rotary Shears; Combination Shear, Punch and Copers; Plate and Angle Bending Rolls; Heavy Duty Grinders
1324 N. KOSTNER AVENUE, CHICAGO 51, ILLINOIS, U. S. A.

FOUND...

15,000 Tons of Scrap at less than $5.00 per ton



Here's how thick ladle skulls are cut to charging box size by the OXWELD C-45 blowpipe.

Here's the story at one steel mill. This mill had accumulated 15,000 tons of skulls and buttons—with nothing to do but bury them. All these became good usable scrap, however, when LINDE showed how they could be cut to charging-box size.

Large skulls, four to six feet in thickness—too thick for oxy-acetylene cutting without some reduction in size, were first pierced by conventional oxygen lancing techniques, and then split in half by blasting. These pieces, and the smaller skulls, such as illustrated, were cut with the oxy-acetylene blowpipe to sizes convenient for charging into the furnace. Of course, many skulls contained inclusions of slag or brick that made normal cutting methods useless. This is the problem that was solved by LINDE's Process Engineering Service.

Total costs to the steel mill averaged less than $5.00 per ton. Because of the economy and ease of operation, reclamation of all skulls has become standard practice at this mill.

Further development work by LINDE points toward greater economies. Field tests just completed on an improved blowpipe have shown that greater depths of cut and lower oxygen consumption rates can be obtained in cutting skulls. The necessity for lancing and blasting will probably be eliminated.

For further information, please inquire at your nearest LINDE Office.

What you can do to help get much-needed scrap to steel mills:

1. Check every scrap source at your plant.
2. Classify and segregate.
3. Move scrap fast through your local scrap dealer.

Linde
Trade-Mark

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation

30 East 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

The words "Linde" and "Oxweld" are registered trade-marks of Union Carbide and Carbon Corporation or its Units.

Illinois Steel Corporation, Duquesne, Pennsylvania. Mr. Yurik is attending the University of Pittsburgh evening division. He started his steel mill career at the Duquesne works in August, 1933, as a loader. He advanced through various positions until his present assignment.

R. J. Wean, Jr., was elected president and treasurer of the Wean Equipment Corporation. Other officers elected are as follows: **J. R. Paisley,** vice president, general manager and assistant treasurer; **G. J. Ridgeway,** secretary; and **L. R. Connor,** assistant secretary. Directors elected are as follows: **S. R. Wean, R. J. Wean, Sr., R. J. Wean, Jr., H. W. Lynn, D. A. McArthur, and J. R. Paisley.**

R. L. Cunningham has been elected president of the Ohio Ferro-Alloys Corporation of Canton, Ohio. The position was vacated by the death of **L. G. Pritz,**

R. L. CUNNINGHAM

late last year. Mr. Cunningham has been an officer of the corporation since 1941, most recently serving as executive vice president. He is also a director of the corporation.

W. W. Pritz has been elected executive vice president of the Ohio Ferro-Alloys Corporation of Canton, Ohio. Mr. Pritz has been with the corporation since 1939,

W. W. PRITZ

having held the positions of works manager and vice president. He is also a director of the corporation.

J. C. Vignos has been re-elected vice president, sales, of the Ohio Ferro-Alloys Corporation of Canton, Ohio.

Lintern

AIRE-RECTIFIER

Installed on Coke Quench Car

This is the first of a series of 16 installations of Lintern Aire-Rectifiers purchased by one of the country's largest steel companies for use on quench cars, larry cars, coke pushers and door cranes.

It is the first installation of its kind anywhere. The fully enclosed cab replaces the old open cab with its hazards of steam, gas, and hot coke . . . results in safety for men and equipment, and assures better and greater production.

The Aire-Rectifier provides normal temperature in the cab of 80° to 85°, protecting the operator against the high temperatures (running up to 130°), and providing clean, healthful air with the coke dust, steam and SO_2 filtered out.

These Aire-Rectifiers are the only ones specifically engineered for all steel mill and foundry applications, and which cover all requirements with standard models. They are the only make universally used the country over, in all types of industrial applications, the result of long specialization in hot metal cab conditioning.

Write for Bulletin AC-111546.

THE LINTERN CORPORATION

54 LINCOLN AVENUE BEREA, OHIO

Glowlite Signals, Lanterns, Markers, Shock Absorbers for Lamps, Ventilating Heaters, Aire-Rectifiers for Overhead Cranes

Announcing

KROMECAST

A NEW CHROME-BASE, HIGH-STRENGTH

3100 F REFRACTORY CASTABLE

B&W KROMECAST...another original development by B&W . . . combines important advantages never before available in chrome-base castables or plastics.

B&W KROMECAST...in addition to supplying chemical resistance at high temperatures to attack by molten slags, mill scale, and other reactive products:

possesses the ability to support loads at elevated temperatures *and can be used in vertical walls and many types of roof arches without support.*

has unusual volume stability at temperatures as high as 3100 F.

can be poured like ordinary concrete, plastered in place, or applied with a cement gun.

B&W KROMECAST means less time spent in building and repairing furnaces. It means longer continuous operating periods. It means lower overall production costs. It opens the way for many new applications that were impossible with previously available chrome-base plastics or castables.

SUGGESTED APPLICATIONS

HEARTHS

FURNACE WALLS

FLOORS

CAR TOPS

DOOR AND FRAME LININGS

ELECTRIC FURNACE ROOFS

FORMING SPECIAL SHAPES

PATCHING

For complete information on this new, unique chrome-base refractory castable, write for Bulletin R-26—or call your local B&W Refractories Engineer.

R-315

B&W REFRACTORIES PRODUCTS

B&W 80 FIREBRICK • B&W JUNIOR FIREBRICK
B&W 80 GLASS TANK BLOCKS • B&W INSULATING FIREBRICK
B&W REFRACTORY CASTABLES, PLASTICS AND MORTARS

•

OTHER B&W PRODUCTS

Stationary & Marine Boilers and Component Equipment
Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers
Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

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Mr. Vignos has been with the corporation since 1934, having held the positions of director of research and general manager of sales. **W. O. Wetherell** has been elected secretary and treasurer of the Ohio Ferro-Alloy Corporation. He succeeds **H. G. Paisley,** who has retired. Mr. Wetherell has been with the corporation since 1935, having served as traffic manager and purchasing agent.

Lester H. Bittner, director of purchases, has been elected vice president in charge of purchases for Allegheny Ludlum Steel Corporation. Mr. Bittner has been associated with the steel industry for 33 years. A

LESTER H. BITTNER

native of Wilkinsburg, Pennsylvania, he joined the Hussey Binns Steel Company in 1915. Five years later he became associated with an Allegheny Ludlum predecessor, Atlas Steel Company (now the company's Dunkirk, New York, plant) as purchasing agent. Mr. Bittner returned to Pittsburgh in 1942 when he assumed his position as director of purchases.

Lawrence A. Franks has been appointed manager of the Boston district office of the H. K. Porter Company, Inc. Mr. Franks, will be located at the H. K. Porter Company, Inc., Boston office, 294 Washington Street, Old South Building, Boston 8, Massachusetts.

Russell M. Braund has been appointed comptroller of American Steel and Wire Company, succeeding **M. W. Field,** deceased. **John W. Jordan** has been named assistant comptroller.

G. L. Thomas was elected manager of the United States Steel and Carnegie Pension Fund, succeeding **H. A. Schultz,** who has retired after 41 years of service with U. S. Steel.

Matthew L. Snodgrass, formerly manager of the furnace division of the Gas Machinery Company, Cleveland, Ohio, has been elected vice president. Mr. Snodgrass will continue to direct the activities of the furnace division.

H. E. McGoff has been appointed Pittsburgh district manager for the Bower Roller Bearing Company of Detroit, Michigan. Mr. McGoff was formerly with Harris Pump and Supply Company.

John M. Davidson has been named Pittsburgh district sales representative for the special chemicals division of the Pennsylvania Salt Manufacturing

(*Please turn to page 143*)

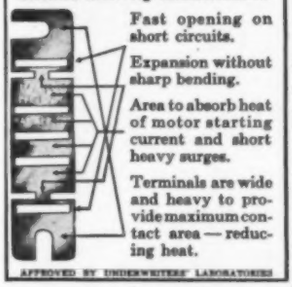
LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

Cool!

WARE HI-LAG Renewable FUSES

Cool Facts No. 1

Strong Time Lag—2 to 5 times normal current, for handling starting overloads and operating surges. Link is one piece of metal, one thickness throughout affording unexcelled time-lag characteristics.


Fast opening on short circuits.
Expansion without sharp bending.
Area to absorb heat of motor starting current and short heavy surges.
Terminals are wide and heavy to provide maximum contact area — reducing heat.
APPROVED BY UNDERWRITERS' LABORATORIES

To secure adequate protection, yet end needless delays and costly shutdowns, calls for WARE HI-LAG Fuses. Scientifically designed and constructed to reduce excessive heating during "round-the-clock" schedules, heavy current loads and starting surges.

The construction of WARE HI-LAG Renewable Fuse provides every advantage for maintaining low contact resistance, strong time lag—up to 5 times normal current.

The Links—the knife-blade assembly—the double bridge supports—the spring tension contacts and greater contact surface are exclusive features which reflect the superior qualities of this amazing cool operator.

We manufacture all of our own parts and are making prompt deliveries.

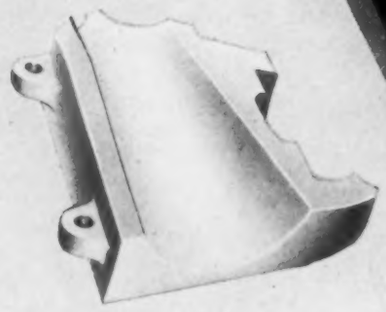
Write for Fuse Booklet No. 4460 giving all features, sizes and details.

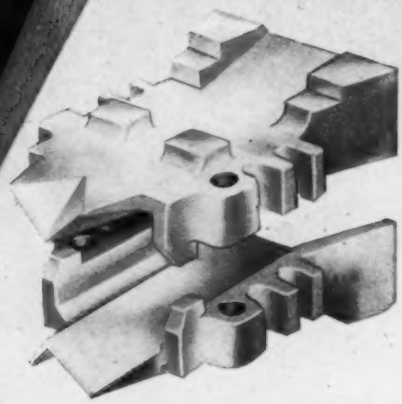
WARE FUSE CORPORATION

4450 W. LAKE ST. CHICAGO 24, ILL.

TRANTINYL

GUIDES THE STEEL INDUSTRY





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JUNE, 1948

(1) Electrode Guide

Publication of a new pocket guide to Airco arc welding electrodes is announced. This handy, compact guide presents all the facts pertaining to the most commonly used Airco electrodes along with helpful data regarding the factors to be considered when choosing an electrode for a specific job. The 4 in. x 8 in. guide is thumb-indexed for ready reference. Section titles include mild steel, high tensile steels, low hydrogen weld metal, stainless steels, surfacing, non-ferrous and cast iron. The information on each electrode mentioned in the new guide includes description, recommended application and welding procedure. Also included is an easy-to-read electrode selection table which gives the operator complete information on which electrode to use for a particular job, its chemical analysis and mechanical properties. A two-page NEMA standard color marking chart and an electrode comparison chart is also featured. (A19-24P) Air Reduction Sales Company.

(2) Air Filters

A bulletin is available describing the complete line of Staynew dry-type intake air filters for all types of air compressors, diesel and gas engines, blowers, motors and generators. The various filters described in this bulletin include silencer models, regular dry-type and breather filters. They range in size from 6 cfm to 8000 cfm in single units. All the filters described in this bulletin feature the original radial finned insert design. (SIF) Dollinger Corporation.

(3) Magnetic Brake

A colorfully illustrated folder has been published describing the "Type M" magnetic brake. Only three simple adjustments, important one-to-one ratio between magnet stroke and total shoe stroke, fewer parts, faster action and simpler design are but a few of the 14 features of superiority available in this mill type d-c brake. The folder describes and illustrates all 14 features and provides dimension and rating tables of special interest to the design engineer. (BR-2) Cutler-Hammer, Inc.

(4) Hydraulic "O" Ring

An engineering manual on hydraulic "O" rings is available. The booklet contains tabulations of compound specifications; dimensional standards — and data on applications, installations, etc., plus drawings showing typical problems of "O" ring usage. Crane Packing Company.

(5) New Roll Grinder

A new bulletin (No. 115) just issued contains complete information about the Farrel heavy duty roll grinder which will be of interest and practical value to engineers and operating men responsible for roll maintenance. The booklet furnishes a thorough description of features of design and construction which, the company claims, give this machine a "Five Point Performance" ability of (1) production with precision, (2) better finish on rolls, (3) savings in time, labor and roll costs, (4) continuous dependability, and (5) a wide range of applications.

Included are tables giving specifications, dimensions and weights, a typical foundation plan, and cross-section views of the Farrel crowning and concaving device, the spindle and wheelhead, and the beds, carriage and neck rests. Among the illustrations are a double-spread pictorial index of design features, several installation views of different size machines, and numerous close-ups of various units of the machine. (115) Farrel-Birmingham Company, Inc.

(6) Electric Hoists

A bulletin introducing additional models and new three and five ton capacity hoists to the "Bob-Cat" line is available. It is claimed the new models have pioneered new fields in design — light weight compared to other heavy duty continuous service hoists — smaller overall dimensions — obtained by mounting the motor on inside of cable drum, is made in three sections, permitting complete and easy access to any part by the removal of but four bolts.

It has a safety factor, so it is claimed, of six to one and better. Made entirely of steel forgings and castings, ball bearing throughout. Gears are all heat treated alloy steel. Lisbon Hoist and Crane Company.

(7) Corrosive Fluids

A new 4-page engineering bulletin giving detailed recommendations on construction materials for almost 400 different corrosive liquids and gases has recently been published. The bulletin was designed specifically for selecting materials to be used in "Flowrator" instruments for measuring flow of corrosive fluids. Therefore material recommendations are listed under three headings having particular reference to this instrument's construction features. First there is a column giving recommendations for end fittings which need only withstand fluid corrosion sufficiently well to give several years life. Then follows a column giving recommendations for the metering floats, which must be completely impervious to the fluid metered. Finally there is a column giving packing material recommendations for the stuffing boxes. Thus the process industry design engineer will find the bulletin helpful in selecting construction materials for machinery quite different than flowmeters. (97) Fischer and Porter Company.

(8) Hydraulic Cylinders

A bulletin is ready for you describing how hydraulic cylinders, with power output up to 7500 pounds, can now be positioned with laboratory accuracy. Remote control

station or stations may be installed at points 1000 feet or more from the location of the cylinder. Accuracy of cylinder movement of 0.1 per cent is obtained. New standard control units are combined to produce this highly accurate, heavy duty positioning system. With this system, a small electric signal is translated into a "position of a hydraulic cylinder." (138-X) Askania Regulator Company.

(9) Induction Heating

Advantages of induction heating in the form of increased production and lower processing costs are covered in a new 12-page bulletin which describes features of Allis-Chalmers heaters ranging from 1 to 100 kw in size. The bulletin presents several dozen examples of successful brazing, soldering, hardening, annealing and heating with Allis-Chalmers induction heaters involving a wide diversity of products. The bulletin calls attention to the company's engineering service available in the form of installation supervision, application engineering, work coil design, and the design of special work handling equipment. It also gives heater specifications and dimensions and touches on the company's line of dielectric heaters, as well as such auxiliary equipment as power transfer switches, sealed water systems and work tables available. (15B6430A) Allis-Chalmers Manufacturing Company.

(10) Mechanical Chargers

A completely new, 36-page, 3-color booklet, illustrated with over 30 drawings and 40 photographs is available. This bulletin will be of great interest to all who contemplate improvement in their charging methods. Nine different systems of mechanical charging are discussed. (FY-153) Whiting Corporation.

(11) Furnace Hood

A booklet describing a furnace hood used in combination with the "Type N Roto-Clone" dust collector to control dust and smoke from electric melting furnaces has been published. Detailed photographs of the hood, which can be varied in design to fit any make of furnace, are contained in the booklet along with installation photographs and descriptive data. American Air Filter Company, Inc.

(12) Dump Truck

Hauling and dumping of scrap, castings, stampings, cuttings, sand, and a wide range of mill and industrial products is made quick and easy with the Phillips "Phil-Dump" Junior. This time and labor saving "Phil-Dump" can be either hand pushed or used with a fork lift truck. This practical model has overall dimensions of 48 in. x 28¼ in. x 38¼ in., and has a capacity of ½ cu yd. Equipped with rubber tires, the "Phil-Dump" Junior affords ease of operation and floor protection. Phillips Mine and Mill Supply Company.

(13) Galvanic Corrosion

A new booklet discussing various aspects of galvanic corrosion has been issued. Prepared by corrosion engineers, it is designed for the production man as well as the research engineer. The booklet not only covers some of the factors influencing galvanic corrosion but also presents data on how galvanic effects can be minimized. International Nickel Company.

(14) Speed Selector

A new broadside on the Speed Selector, which permits stepless, infinite ratio changes in rapid succession by a new development in planetary motion has just been published. By utilizing two V-belts and four variable pitch sheaves, the variable-V-planetary of the Speed Selector provides any speed change from zero to 800 rpm at constant torque. A slight change in the sheaves results in a large shift in output speed through the medium of the planetary. The broadside describes the principles of operation of the Speed Selector, pictures some of the most recent successful applications of the product, and lists a large number of machines on which it can be utilized. Data tables for the ½, one and two horsepower models in which the machine is made are a feature of the broadside. (2195-2-1-48) B. F. Goodrich Company.

(15) Magnetic Separator

A data sheet has been issued incorporating special features, typical applications and a table of dimensions and capacities covering the new Dings "Alnico Perma-Pulley" magnetic separator. These new non-electric pulley type separators are designed for automatically separating magnetic and non-magnetic dry materials. (B-1009A) Dings Magnetic Separator Company.

(16) Steel Heating Process

How to save fuel, increase refractory life, and reduce maintenance costs in steel heating operations are features of the new Urquhart combustion process which are described in a four-page bulletin recently published. Conducted on a principle of atmosphere control which eliminates secondary combustion on the refractories and work, the process produces uniformly heated steel which reduces the need for grinding, chipping, and scarfing. The process is being used extensively in rotary hearth, slot type forge, and batch type forge furnaces, soaking pits, and in multiple pot type and day tanks in the glass industry. Oil and gas are used interchangeably in this system, so full-scale production is maintained during a shortage of either one of these fuels. Steel Processing Company.

(17) Tap Data

A 64-page handbook of tap data and catalog information on Sheffield high speed commercial and precision ground taps, both standard and special is now available. This is a new line of products and the taps are said to provide hardness without brittleness as well as uniform extra strength, the result of carefully selected steels heat treated in precision controlled equipment. According to the announcement immediate delivery from stock can be made on standard 3 and 4 fluted and spiral pointed hand taps, standard and spiral pointed machine screw taps, and pipe taps, American national pipe taper and straight. The Sheffield Corporation.

(18) Materials Handling

"HANDLING MATERIALS," one of the first publications devoted exclusively to the science of materials handling, assumed an entirely new format in its initial 1948 issue. The magazine, published quarterly by Towmotor is now known as "HANDLING MATERIALS-ILLUSTRATED." Changes in the publication include a tabloid format which permits use of more, larger photographs. Copy is brief and terse, with more space being devoted to sequence photos of actual handling operations in every type of industry. A reply card, enclosed in each copy, offers additional detailed information on each of the several subjects covered in each issue. (Vol. VI, No. 1) Towmotor Corporation.

(19) Rectifiers

A 28-page illustrated booklet on a complete line of copper-oxide rectifiers and controls for electroplating, anodizing, electrocleaning, electropolishing and other electrolytic processes has been announced. The booklet explains the advantages of unit installation of rectifiers over the old central power supply system and points out the advantages of "package power," which offers flexible, low-cost power and control equipment tailored to fit all modern plating and anodizing requirements. Technical diagrams and tables listing the complete range of packages for both manually and automatically controlled rectifiers and what they will do are also given.

As an aid to manufacturers in their planning, the publication carries illustrations of typical installations of these rectifiers and controls. (Bridgeport) General Electric Company.

(20) Meehanite Castings

A new 8-page bulletin entitled "7 Questions and Answers About Meehanite Castings" has just been prepared. The booklet by the means of answering seven fundamental questions explains in a concise manner just exactly what Meehanite metal is and the basic characteristics which it makes available to industrial users of iron castings. (28) Meehanite Metal Corporation.

(21) Steam and Water Mixer

A new steam and water mixer to provide hot water at isolated points is described in a new catalog. The mixer eliminates piping of hot water long distances or installing separate heaters in remote wash rooms or showers. Takes up little space and delivers hot water at your pre-determined temperature. In 2-colors, the cut-away photographs show operation, installation, and construction. Convenient capacity and dimension tables are included. (900) Sarco Company, Inc.

(22) Geared Motors

The use of geared motor power in driving machinery and the presentation of latest electrical motor models are dramatically shown in a multi-colored 16-page bulletin just issued. Comparative drawings showing common construction in contrast to the new design features of "Syncrogear" motors give a new conception of motors for

geared application. Advantages of using hardened gears and pinions to obtain greatest wear resistance and methods of attaining hardness are described. The bulletin also presents the several latest models in single, double, and triple reductions and for use in combination with Varidrive units. Sizes range from ¼ to 30 hp and standard AGMA speeds of 10 to 10,000 rpm. The advantage of using a pyramidal base to prevent internal and external stresses are illustrated. (F-1498) U. S. Electrical Motors, Inc.

(23) Battery Research

Introducing the staff and facilities of the first complete research laboratory and development-pilot-plant in the storage battery field, the Gould Storage Battery Corporation has just published a new 16-page fully illustrated booklet, "Better Batteries for Industry Through Research." It is available without charge to all who are interested in direct current supplies for materials handling, communications, switchgear operations, warehousing, diesel power, and general industrial purposes.

Principal subjects treated include: the analysis and control of battery metals through the use of the ultraviolet spectrograph and densitometer; instantaneous voltage and current characteristics as studied by cathode-ray oscillograph; X-ray diffraction methods of studying battery chemicals and the changes therein which occur in battery life; studies of crystalline structure through the metallograph and binocular microscope; physical testing of battery structural materials; cycling and life testing; and the complete 300-batteries-per-day Pilot Plant using actual battery production tools in miniature.

(24) Pumps for Abusive Service

A bulletin just released presents the most recent developments in a line of horizontal and vertical shaft centrifugal pumps which combine efficiency, simplicity and ruggedness, plus the characteristics needed for the abusive processes in industry. These applications include pumping corrosive or hot liquids and abrasive or heavily laden mixtures. This 36-page bulletin demonstrates how design, materials of construction and intelligent application have been coordinated in industrial pumps enabling them to perform the most abusive pumping jobs economically, with a minimum of out-time and maintenance. The two horizontal shaft and three vertical shaft types of pumps are illustrated and fully described in the bulletin. Special types recently developed for various applications are also presented. The five classes of impellers, designed to meet all conditions, are shown, with recommendations for various applications. (4711) Nagle Pumps.

(25) Centralized Lubrication

"Studies in Centralized Lubrication" is a subject of a booklet that is available to you. This booklet contains descriptions of various installations of centralized lubrication, showing the dollar savings and the time savings in each one. Six studies are contained in this bulletin. Farval Corporation.

(26) Sheaves and Pins

A folder is available describing how you can hoist your profits with "Tool Steel" process sheaves and pins. These sheaves and pins are hardened to meet the most severe requirements. Each part is made from low carbon steel, is subjected to the exclusive and special "Tool Steel" process for greatest surface hardness and depth of case, then further treated for maximum core refinement. (947) The Tool Steel Gear and Pinion Company.

(27) Fuel Oil Treatment

Proven facts about "Dacarol" fuel oil treatment for industrial furnaces are given in a bulletin that is available to you. "Dacarol's" efficiency has been proved in actual practice in the burning of more than 500 million gallons of treated fuel oil. Complete, systematic records, which were kept over a period of two years, disprove what is a common fallacy among fuel oil users: the assumption that all fuel oil treatments serve only to disperse sludge — that if fuel oil tanks are free from sludge, there is no purpose in treating the oil. These records prove that sludge removal is only one of several important functions of this fuel oil treatment, and that it safeguards equipment and efficiency of operation from fuel oil storage tanks to burners. Dacar Chemical Products Company.

(28) Power Trucks

Heavy duty handling trucks at work in industrial plants are described and illustrated in a booklet that is available to you. Action photos reveal how effectively a truck operator manipulates loads weighing 50,000 lb or more. Facts are given relating to speed and economies with which trucks move loads. One-man control of motors and mechanisms governing movement of truck, its platform elevating device, reels and cables, provide for safe, low-cost facilities. The booklet gives principal specifications of truck models ranging from 2000 to 54,000 lb carrying capacities. (A-9657) The Elwell-Parker Electric Company.

(29) Traffic Lines

A folder is available on the "Streme-Liner." This machine will make industrial traffic lines, which are so important for plant safety, so effective for plant neatness and essential for material handling. The design of the paint shield mechanism permits operation over any type surface. Clean-cut results are obtainable whether surface is smooth or rough. Three adjustments in the "Streme-Liner," quickly and easily made, will permit fractional graduation in the width of the line from 3 in. to 8 in. If you are interested in having your plant marked clearly with lines, we suggest that you send for this folder. Industrial Tools and Products Corporation.

(30) A-C Generators

A folder is available on high speed, revolving field type synchronous a-c generators. These generators can be used for coupled or belted service. They conform to NEMA standards; anti-friction bearings are standard equipment. These generators are designed to operate over a period of many years with minimum maintenance. They are engineered and produced to exacting standards, assuring the user of dependable service. (800) Columbia Electric Manufacturing Company.

(31) Detachable Chain

A new bulletin is available describing pressed steel detachable chains. Complete specifications and price lists are given for plain and attachment chains. Information to aid in determining what sprockets are advisable for use with this chain is also given. (48-26) Chain Belt Company.

(32) Buckets

A booklet is available on buckets for single drum hoists and hook-on applica-

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tions. This 50-page booklet is designed to simplify the problem of selecting the proper bucket to meet operating requirements when single drum hoists and hook-on applications are involved. The booklet defines the various types of buckets and gives the operating requirements of each bucket. There is a bucket in this booklet for every type of materials moving problem confronting industrial plants. A section on ingot tongs is also included which will be of interest to open hearth men. (2002) Blaw-Knox Division of Blaw-Knox Company.

(33) Refractory Insulation

A leaflet is available giving complete information on the object and advantages of a flexible, unit supported, insulated refractory backing for close-spaced water walls. A cutaway view shows how this refractory backing is installed. (947) The George P. Reintjes Company.

(34) Synchronous Motors

A folder is available on synchronous motors from 10 to 1000 hp. These motors are built for applications that demand a quality far superior to that of ordinary commercial machines. Proof of this accumulated design and manufacturing experience is evident in every unit. Each of these synchronous motors is designed and built for its individual application. (B-211) The Electric Products Company.

(35) Reflectoscope

Testing of welds in plate, thin sheet, and other sections with a supersonic reflectoscope, using a new angle transmitter, is fully described in data sheets available to you. (3021) Sperry Products, Inc.

(36) Resin Coating

Booklets have just been released on acid and alkali resistant resin coating, acid and alkali proof tank lining and acid and alkali proof resin coating. These products are made by specialists in acid and alkali proof materials and constructions. This company is equipped to design and construct all types of storage and pickling tanks, sewers, sumps, pits and other processes. Where customers prefer to design and build their own installations, this company will furnish complete materials and full supervision. (24, 35 and 40) Nukem Products Corporation.

(37) Watthour Meter

A booklet is available describing the first completely new watthour meter in fifty years. The "I-50" is the result of a long succession of engineering advances culminating in a completely new meter which has magnetic suspension, a radically new and stable damping system, and an ingenious new electro-magnet with polyethylene and butyl insulations. (GEC-350) General Electric Company.

(38) Aluminum Coating

Most aluminum paints look alike. For this reason many users of aluminum paints underestimate the importance of employing the correct coating for a particular use. A bulletin is available to all who have the problem of selecting the proper aluminum finish for their particular application. As a further aid, a handy selector chart is included in the bulletin, whereby an aluminum coating may easily be chosen by matching the requirements to one of the nine aluminum paints listed. The requirements are divided into properties, applications and resistance data, so that at a glance the most suitable aluminum finish may be selected. (AD 150-3) Brooklyn Varnish Manufacturing Company, Inc

(39) Iron Lung

The 1948 catalog on the iron lung has just come off the press. This folder describes how the iron lung was the first roof ventilator engineered for power operation. It is not a converted gravity-type unit. The iron lung is famed for the speed with which it exhausts large volumes of polluted air from industrial buildings, bringing in fresh air to maintain the health and energy of workers. There are records to prove that this installation has decreased absenteeism and labor turn-over; has increased production and has prevented labor disagreements from developing into worse situations. If you have a problem in air pollution, we would suggest that you send for this bulletin. Powermatic Ventilator Company.

(40) Steam Detergent

A folder is available which describes an industrial steam detergent cleaning process which can be used in the steel industry to great advantage. Steam detergent cleaning may be defined as the simultaneous application of three different actions: the physical action of steam pressures in hot water working their way through successive lines of grease and dirt, the dissolving action on oil and grease and the mechanical action of the detergent in setting, generating and emulsifying acid dispersion. We would suggest that all steel mill men investigate this new application. (7238) Oakite Products, Inc.

(41) Carbide Tools

Publication of a revised tool catalog covering "Talide" tungsten carbide tools and tips is announced. This catalog incorporates the new standard identification numbers recently adopted by the carbide industry. Also included are several new styles and sizes of cutting tools and tips. (48-T). Metal Carbides Corporation.

(42) Test Chambers

A new 32-page catalog illustrating a complete line of temperature, altitude and humidity simulating units is available to engineers and plant managers. Included in the catalog are altitude-pressure-temperature curve graphs; thermal property tables for various materials; Fahrenheit table of relative humidity or per cent of saturation; and other charts of value in research, testing and production processing. The development, history and advancement of test cabinets and industrial processing units are outlined, and the latest equipment illustrated and described. Bowser, Inc.

(43) Gearmotors

A folder describing the properties and advantages of "Kaylo" heat insulating block is being released. It is the first "Kaylo" literature made available by the company for general distribution. The insulating block made its public debut in the insulation field only recently, but has an enviable World War II record. Developed at the beginning of the war, the lightweight but strong mineral insulation was drafted for the armed forces and essential industries. The limited output of a pilot plant in Berlin, New Jersey, went into ships, "hot process" plants, and other installations where an insulation that would not break down under intense heat was vital. (485). American Structural Products Company.

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(*Continued from page 137*)

Company. Mr. Davidson formerly was sales representative in the northern New Jersey and New York City territory.

Mr. Davidson fills the post formerly held by **William J. Hennessy,** now Pittsburgh district sales manager of the special chemicals division.

Mr. Davidson graduated from Dickinson College with a bachelor of arts degree and earned a degree of master of education at Temple University.

Walter Geist was recently elected to his seventh term as president of the Allis-Chalmers Manufacturing Company and all directors and officers were re-elected at the annual meeting of the firm's stockholders and board of directors.

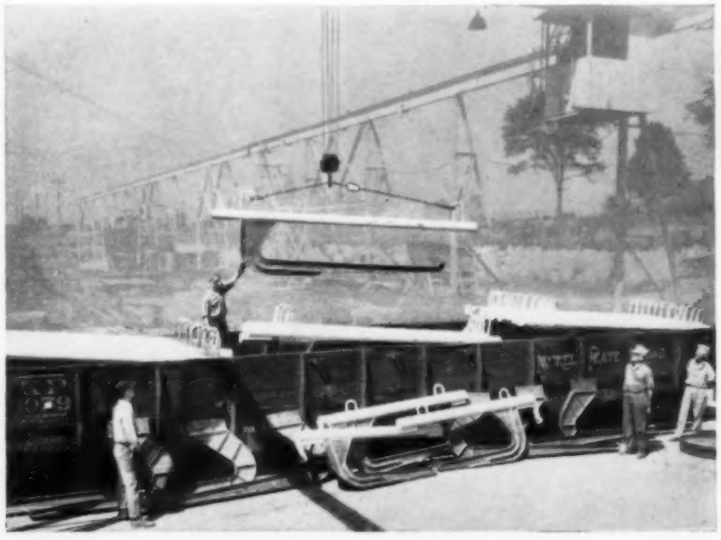
Obituary

A. F. Morris, chairman of the board, Morgan Engineering Company, died at his home, 893 Parkway Boulevard, Alliance, Ohio, on May 3. Mr. Morris spent his entire career with Morgan Engineering Company except for a six months period in his youth. He started as office boy in October, 1887. In 1888, he left Morgan to join his father in the grocery business but returned six months later to stay for the rest of his life. When he went back to Morgan, he became a clerk in the office. He showed steady progress and became paymaster and cost accountant. In 1899, he entered Morgan's sales department and continued his progress until 1901 when he became sales manager. In 1923, he was elected vice president and sales manager and became company president in 1928. In 1946, he was elected chairman of the board of directors.

A. F. MORRIS

Mr. Morris was born June 6, 1870 and attended public schools in Alliance, Ohio. He was a life member of the Association of Iron and Steel Engineers.

William C. A. Busch, superintendent, construction department, Lukens Steel Company and its divisions, By-Products Steel Company and Lukenweld, Coatesville, Pennsylvania, died suddenly, May 20, of a heart attack at his home, Caln Meetinghouse Road. He was



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WELDCO HAIRPIN HOOKS SPEED UP YOUR PICKLING AND MATERIAL HANDLING OPERATIONS

● Here's another carload of Weldco hairpin hooks, ready for shipment to one of the country's largest steel plants. These pickling hooks are lightweight but tough . . . designed to handle loads as heavy as 3,000 to 5,000 pounds, easily and safely. Weldco hairpin hooks withstand hot pickling acids, too; in fact, they're more corrosion-resistant—more durable—than many heavier hooks.

Weldco pickling hooks are made of Monel, and can be furnished in various other alloys. Put these sturdy, lightweight hooks to work in your plant—then watch your pickling and material handling costs go down.

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Dravo Crane Cab Coolers are simple to install; all parts are readily accessible for servicing.

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Operators of hot-metal cranes are more alert and efficient when you protect them from fatigue and discomfort by air conditioning the cabs with Dravo Crane Cab Coolers.

Completely self-contained, and requiring only an electrical connection, the Dravo Crane Cab Cooler provides complete air conditioning:

Cooling	Continuous Ventilation
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69 years old. Mr. Busch was born in Harrisburg, Pennsylvania, January 17, 1879. He joined Lukens Steel Company, January 21, 1927 as superintendent of masonry. He held that position until July 1, 1939, when he was made superintendent, construction department, which position he held at the time of his death.

Before joining Lukens, Mr. Busch was employed by Trumbull Steel Company, Warren, Ohio.

Peter D. White, who was recently elected president of Babcock and Wilcox Tube Company died suddenly May 6. Mr. White, who was born in Dublin, Ireland, June 25, 1889, came to this country in 1907. He was graduated in the class of 1911 from Massachusetts Institute of Technology where he won fame as a track star. After holding a minor job with the Canadian Pacific Railroad, he started his career with the Babcock and Wilcox organization as an assistant machinist.

He had been with the Babcock and Wilcox organization 33 years. During the past year he had been executive vice president and a director, and was previously vice president for five years. Mr. White came to the Bayonne, New Jersey, plant in March, 1915, and later became executive assistant to Isaac Harter, then vice president of Babcock and Wilcox Company, in charge of manufacturing activities. In April, 1939, he was transferred to Beaver Falls, and in January 1943, was elected vice president and general manager of Babcock and Wilcox Tube Company. He later became executive vice president, and last month was elected to the presidency.

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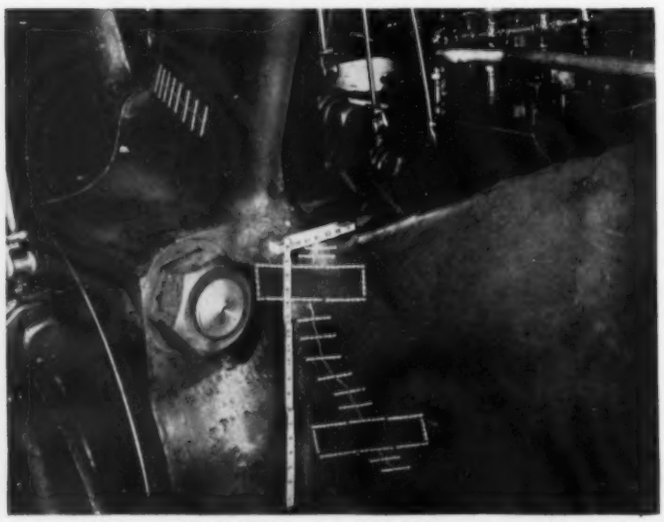
THOUSANDS SAVED BY *On location* REPAIRS WITH METALOCK

38 TON FLYWHEEL REPAIRED ON LOCATION—PASSED INSURANCE REQUIREMENTS



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We asked a few Operators how they are doing with

ANGLE FLOW TUYERES

U. S. Pat. 2,124,437

Tuyere at top-center of illustration is Angle Flow type with refractory nose.

Here's What They Reported . . .

Increased requests for the Angle Flow Tuyere, both with and without refractory nose, prompted us to check current results with angle flow installations. These operators enthusiastically reported greatly improved conditions, reduced burning after a switch to Angle Flow Tuyeres.

With tuyere pointed down (towards six o'clock) one operator reports his tuyere life increased from 24 days on conventional type to 100 days with refractory nose Angle Flow Tuyeres. Another who was getting from 30 to 35 days on a conventional type had had Angle Flow units with refractory nose in operation for 60 days and they still remained in the furnace. A third operator stated that he had been burning certain tuyeres nearly every day and that Angle Flow Tuyeres had apparently corrected this condition.

Other reports equally favored Angle Flow Tuyeres. There is every indication that this tuyere design, in Falcon quality casting, is capable of eliminating many troublesome, costly burning problems. Certainly they warrant a trial installation. Falcon is licensed to produce the Angle Flow Tuyere under U. S. Pat. No. 2,124,437 and is prepared to offer prompt delivery.

TELEPHONE COLLECT - 3-4353

FALCON BRONZE CO.

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DATE LINE DIARY...

May 1

▲ Paul Hoffman, the administrator of the Marshall plan, estimates that steel needed during the first year of the program will be about 4 million tons. This quantity will have little effect on steel supplies since we have been shipping that much at the present time.

May 2

▲ It is expected that zinc will continue to be in great demand. At the present time, galvanizing, which is the biggest user of zinc, is taking 45 per cent of all slab zinc. As a consequence, zinc stocks are still declining, indicating that present usage is in excess of domestic production plus imports.

May 3

▲ Inland Steel Company filed an appeal from a recent decision of the NLRB, in order to save their voluntary retirement plan. The NLRB had stated that the company must bargain with the United Steelworkers of America on this subject. Inland expressed the fear that the decision, if upheld, might endanger long-established pension and retirement benefit plans for employees in private companies throughout the nation.

▲ Inland Steel Company announced price reductions on its products, aggregating approximately $3,500,000.

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 91.0 per cent of capacity for the week beginning May 3, 1948, equivalent to 1,640,300 tons of steel ingots and castings, compared to 1,560,900 tons one week ago.

May 4

▲ The United States Supreme Court decision outlawing the multiple basing point system in cement pricing may cause major changes in the marketing of steel and other products. The decision may result in concentration of industry closer to their source of steel supply.

May 5

▲ American Railway Car Institute announced that freight car deliveries in April were 9052. New car orders during the month totaled 18,252, for a record month since 1941.

May 6

▲ Jones and Laughlin Steel Corporation announced that as its contribution to the effort to halt inflation, it will make price reductions on a number of steel products which will save 3½ million dollars annually.

May 7

▲ Irving S. Olds, chairman of the Board, U. S. Steel Corporation, stated that the corporation produced a total of 28,570,000 tons of steel ingots and castings and operated at 96.7 per cent of rated capacity during 1947. Shipments of finished steel were 20,242,000 tons. The income was $127,098,148, which was equivalent to a return of 6 per cent on sales, and to a return before interest of 7.4 per cent on investment. He also stated that expenditures in 1947 on the $800,000,000 postwar improvement program had been approximately $206,000,000. Approximately $400,000,000 worth of improvements and additions remain to be completed. He also estimated that up to April 25, the coal strike had cost the corporation a loss of about 3,200,000 tons of coal, 430,000 tons of pig iron, and 430,000 tons of steel ingots.

May 8

▲ By this time, it is seen that the various price reductions throughout the industry are not the same on the same items for different companies, but vary throughout the range of products. Some items have not been cut by some companies which have been cut in price by others.

May 9

▲ Net profits for the first quarter in 1948, according to the reports of the steel producers, average about 10 per cent less than during the first quarter of 1947. This decrease reflects rising production costs which more than compensate for the near capacity operations and record sales.

May 10

▲ American Iron and Steel Institute announced today that first quarter shipments of steel products totaled approximately 16,438,000 tons. If the coal strike had not interrupted this high rate of activity, total shipments for 1948 would have exceeded those of the record wartime year of 1944.

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 94.3 per cent of capacity for the week beginning May 10, 1948, equivalent to 1,699,700 tons of steel ingots and castings, compared to 1,640,300 tons one week ago.

May 11

▲ Total payroll of the iron and steel industry during March 1948 was $183,045,000 for a new all-time record. Total employment was 628,800 wage earners and salaried workers for a new postwar peak.

May 12

▲ Effective today, ARMCO Steel Corporation announced price reductions on a number of products, ranging from $1.00 to $3.00 per ton.

▲ In a statement made by T. M. Girdler and C. M. White at the annual stockholder's meeting of the Republic Steel Corporation; they pointed out that the composite steel price index has risen only 40 per cent since 1939 while hourly wages for the same period are up 85 per cent, steel scrap 145 per cent and coke 205 per cent.

May 13

▲ The Jones and Laughlin Steel Corporation filed legal actions against alleged gray market operators in Detroit and Chicago. The defendents were charged with offering to sell 7500 tons of J & L ingots per month for a period of a year to the Ford Motor Company at a gray market price of $75 per ton. These legal actions were the first to be instituted by any steel producer against such operators.

▲ The first major work stoppage in the metal working industry occurred yesterday when 75,000 Chrysler Corporation employees left their jobs. Up to this time, most major industries have refused demands for substantial wage boosts. What happens at Chrysler may set a pattern for industry as a whole. It is believed that the strike may last for some time.

May 14

▲ H. H. Waldschmidt of the Youngstown Sheet and Tube Company pointed out that the purchasing department of a large steel plant must procure from 35,000 to 40,000 different items. At the present time, such procurement is complicated by rising prices and scarcities.

May 16

▲ Thomas J. Hilliard, sales vice president of the Carnegie-Illinois Steel Corporation disclosed that manufacturers of finished steel products are turning in increasing numbers to the use of high-strength steels that permit the production of as many as one-third more finished product, ton for ton, than carbon steel.

May 17

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 95.4 per cent of capacity for the week beginning May 17, 1948, equivalent to 1,719,600 tons of steel ingots and castings, compared to 1,699,700 tons one week ago.

May 18

▲ Ernest T. Weir, chairman of National Steel Corporation, announced price reductions averaging $1.50 per ton on the company's shipments of finished products.

May 19

▲ Association of American Railroads announced today that railroads have turned back to the iron and steel industry more than a ton of scrap metal for every two tons of iron and steel they bought during the past four years. In 1947, railroads and railroad equipment builders obtained 6,029,000 tons of rolled steel which went into various railroad uses.

May 20

▲ Dr. R. E. Zimmerman, vice president — research and technology, United States Steel Corporation of Delaware, declared today that the steel industry has decided on a sound and orderly course of expansion so as to maintain steel prices at the lowest possible level. He pointed out that one of the big factors in expansion is the tightness of raw materials. Additional iron requires more blast furnaces, more ore and more coke. Additional ore will probably require additional mines and additional transportation. More coke in turn will require more by-product ovens. High cost of construction is an important factor and if based on the present four per cent depreciation charge, the cost for depreciation would be $12 per ton, assuming $300 of capital investment is required per ton of finished steel.

May 21

▲ It is expected that in 1948, world production of tin will rise as high as 160,000 tons. This compares with 110,000 tons in 1947 and 87,000 tons in 1946. This estimate is based on the assumption that political stability in Bolivia and the Far Eastern tin producing countries will prevail.

May 24

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 96.8 per cent of capacity for the week beginning May 24, 1948, equivalent to 1,744,800 tons of steel ingots and castings, compared to 1,719,600 tons one week ago.

May 25

▲ Lowell B. Mason, a member of the Federal Trade Commission, believes that trade associations suffered what may be a fatal blow in the Supreme Court's decision in the cement case. He predicts that if the laws stand as they now are, the present administrative trend will make life so uncomfortable for members of associations that the hazards of membership will hardly be worth any advantages. He felt that the court's decision throws out multiple basing point pricing as a matter of law. He also believes that it is out as a matter of plain economics, and Mr. Mason stated that there are more businessmen in this country who would welcome a mill base at every point of production than there are businessmen who wish to maintain either the Pittsburgh plus or the multiple basing point system.

May 26

▲ One steel authority has stated that the Russians, in their plans, use three times as many men to produce a ton of steel as is now required in this country.

May 27

▲ Walter S. Tower, president of the American Iron and Steel Institute, in an address before the General Meeting of the Institute stated that definite legislation is imperative to clarify the status of pricing methods and prevent disruptive effects threatened by the recent Supreme Court decision in the cement case.

▲ John L. Lewis has indicated that he will bring up the pension problem at the coal negotiations when they come up again. This may affect the use of the injunction because the government cannot use the injunction if the same subject is in dispute and after the 80 day cooling off period provided by the Taft-Hartley bill has been respected.

May 28

▲ The United Steelworkers, at their fourth annual convention in Boston, voted to increase the monthly dues from $1.50 to $2.00. This increase may have been made in order to provide an emergency chest for a future strike.

May 29

▲ Professor E. W. Davis of the University of Minnesota announced yesterday that very successful experiments have been made for producing pig iron from taconite. The smelting tests culminated more than 20 years of work. Mr. Davis also stated that four to five times as many men will be needed to produce ore from taconite as from high-grade ore. A $2,000,000 plant near Aurora, Minnesota, is starting semi-commercial production next fall on the basis of 200,000 tons a year.

May 31

▲ The agreement of the General Motors Corporation of an eleven cent wage increase to its 225,000 production workers was a surprise to the other metal working industries. Future negotiations will undoubtedly be vitally affected by this decision. The agreement contains a clause hitching future wage rates to the cost of living index. Under this provision, adjustments to bring wage rates in line with the changes in living costs will be made.

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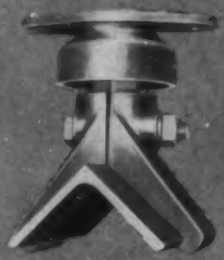
CONTACT RAIL INSULATORS
UNDER-RUNNING TYPE



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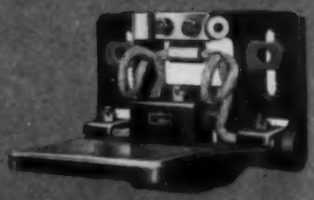

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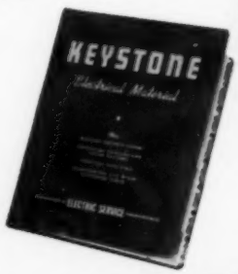

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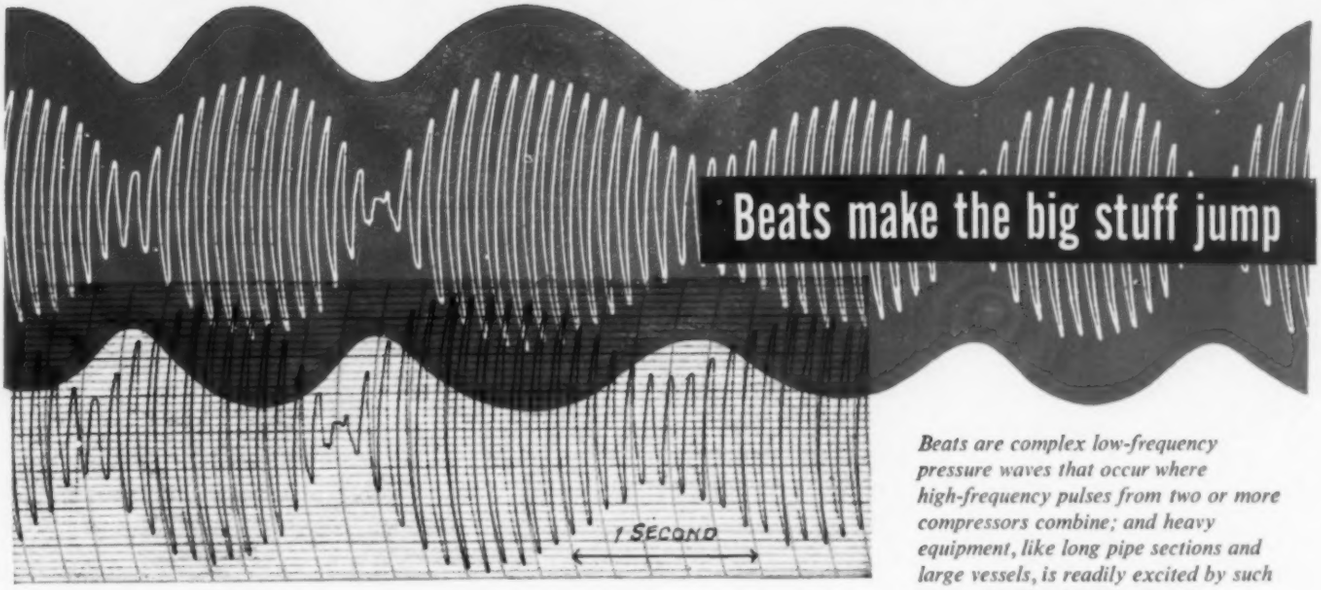

Beats are complex low-frequency pressure waves that occur where high-frequency pulses from two or more compressors combine; and heavy equipment, like long pipe sections and large vessels, is readily excited by such waves. So when beats occur, it's trouble ahead for the big stuff. (Chart shows one complete cycle of beats in a compressor suction system.)

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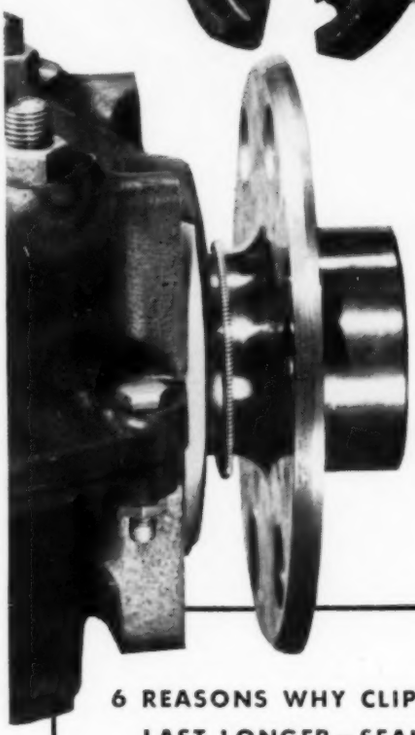

HOW TO INSTALL AN OIL SEAL IN 10 SECONDS FLAT

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Completely new in principle, Clipper Seals have no metal case. Their rigid heel and soft flexible lip are moulded into a single unit to provide a seal of superior lubricant-retaining, dirt-excluding qualities. The garter spring adjusts lip pressure, contributes to more effective sealing and longer life.

Clipper Seals are made in both split and endless types and are available for shafts up to 66″ in diameter. They are recommended for sealing against oil, grease, water, air, grit and coolants at operating temperatures up to 450° F.

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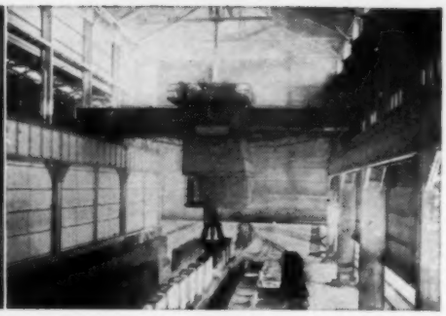

Morgan ingot stripper.

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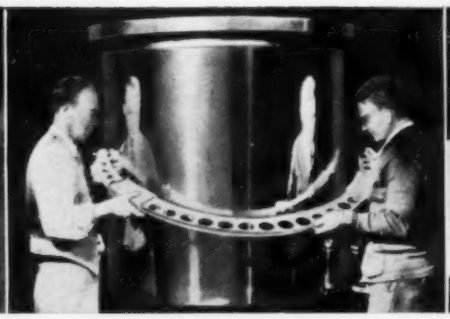
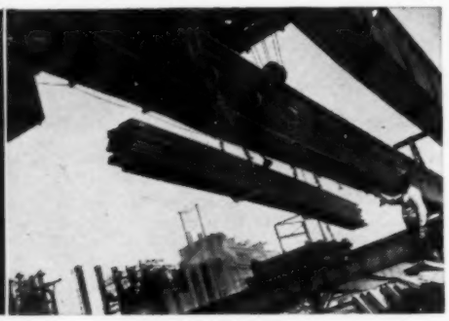


Morgoil bearing journal sleeve.



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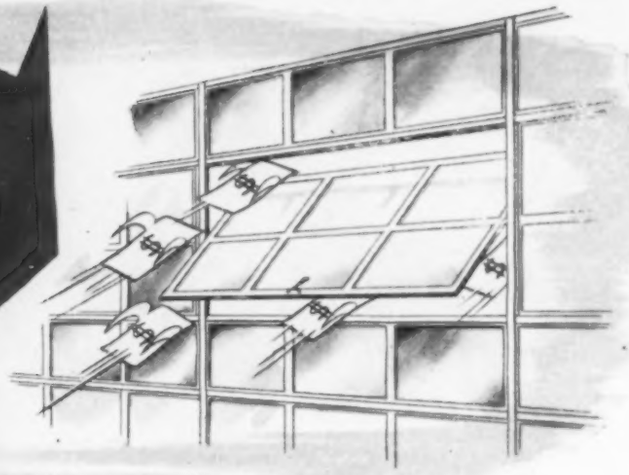

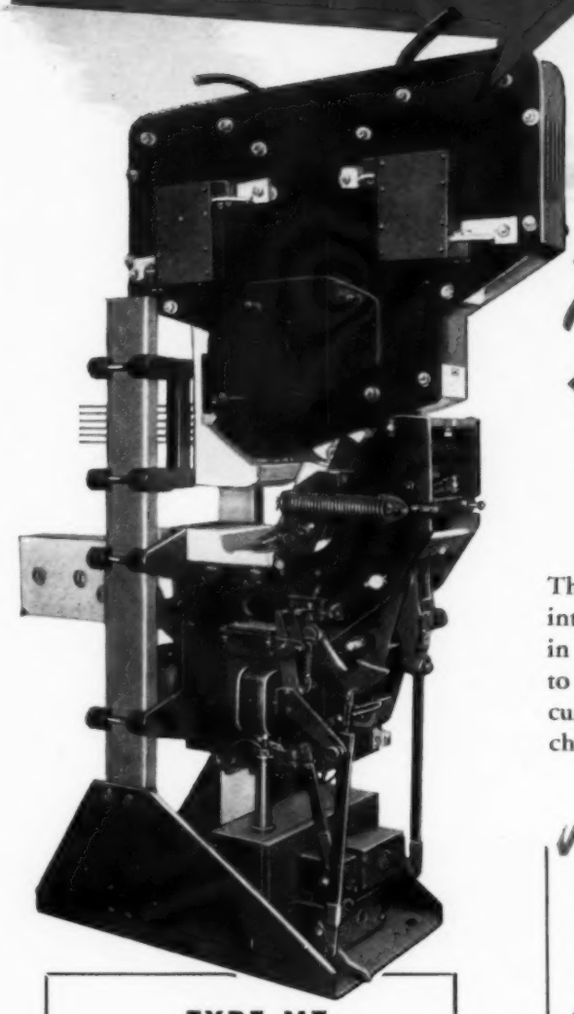

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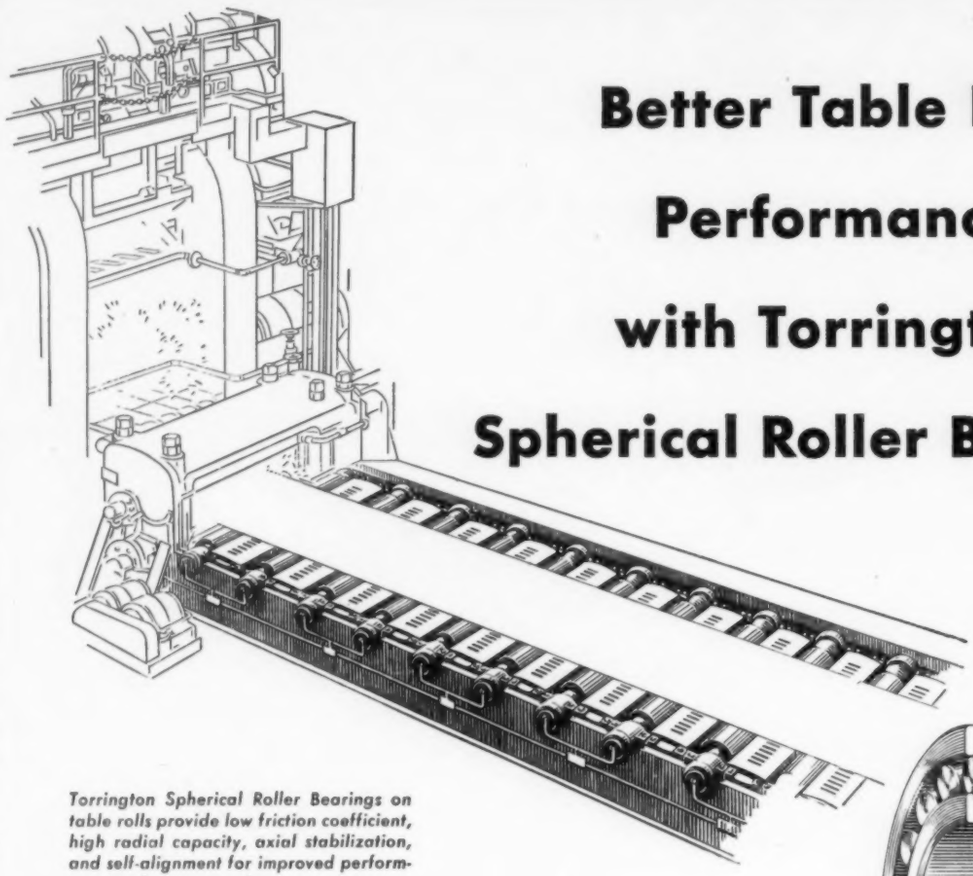

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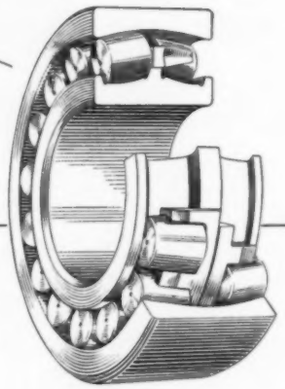

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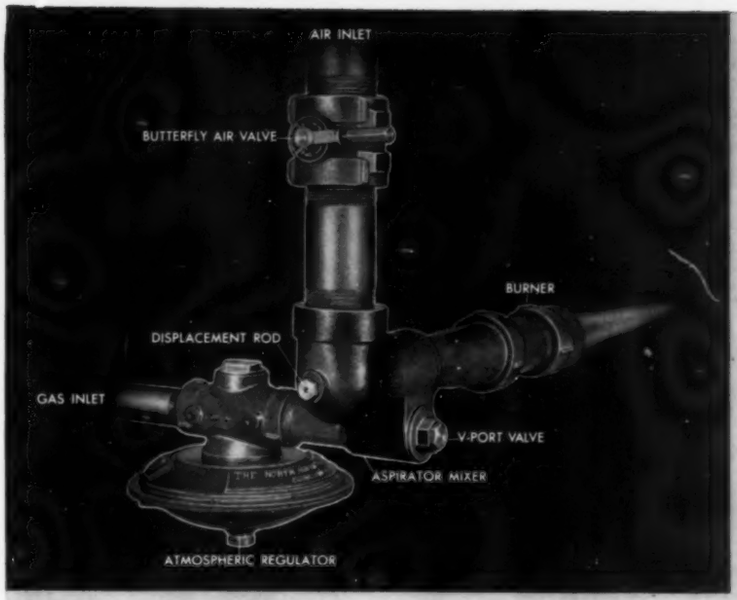

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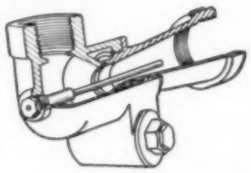
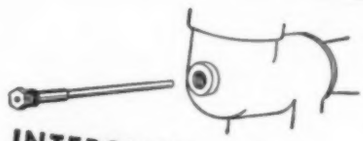


EFFICIENT DESIGN

and precision manufacture of the internal parts enable the air flowing through the mixer to create enough suction to draw the gas into the mixer and deliver an intimate mixture of gas and air to the burners at high pressure.



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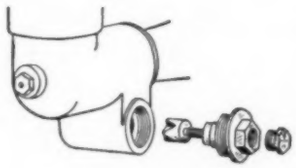
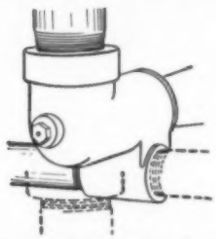


SENSITIVE V-PORT ADJUSTMENT

provides positive setting of the gas-air ratio on any gas from 500 to 3200 Btu per cubic foot (20 complete turns of the valve are required to go from fully open to fully closed).



COMPACT, FLEXIBLE DESIGN

makes the North American Aspirator Mixer easy to install on any industrial furnace or oven. Over-all length not excessive.

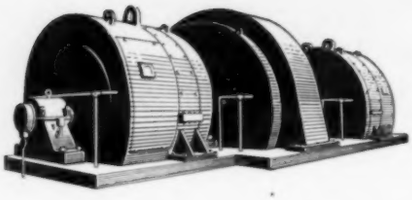
THE NORTH AMERICAN MANUFACTURING COMPANY

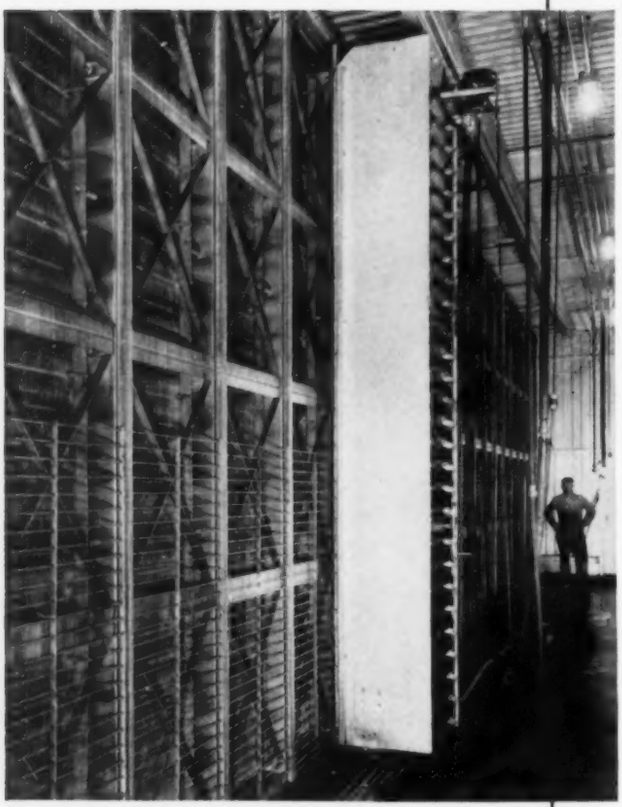
MANUFACTURERS OF INDUSTRIAL FUEL BURNING EQUIPMENT FOR GAS OR OIL

BRANCH OFFICES *with* FIELD ENGINEERS *in* PRINCIPAL CITIES

CLEVELAND 5, OHIO

Where SUPER-CLEAN AIR for mill motors is a "must"





An Electro-Cell Precipitator of 216,000 CFM capacity with AAF automatic washers now in its third year of service.

AAF Electro-Cell combines high cleaning efficiency with ease of maintenance

WHERE conditions permit no compromise in the cleanliness of the air supplied for cooling mill motors, the AAF Electro-Cell is your logical choice. This electronic precipitator gives positive protection against dust and smoke—even down to fractional micron sizes.

Removable collector plate cells permit selection of maintenance method best suited to your operation. Cells may be manually washed and re-oiled in place; removed for easy cleaning in a special tank, or washed, dried and recoated automatically (as illustrated) with minimum interruption to operation.

Electro-Cell's sectional construction reduces weight of parts, eliminates multiplicity of electrical connections, protects wiring from dirt and water. And its full-height hinged or removable ionizers minimize electrical losses, reduce ozone and simplify replacement of ionizing wires.

If you want super-clean air plus proven savings in operation and maintenance, get complete Electro-Cell data now. Just contact your local AAF representative or write direct for Bulletin No. 252.

AMERICAN AIR FILTER COMPANY, INC.
302 Central Avenue, Louisville 8, Ky.
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AAF
AIR FILTERS
AND DUST CONTROL EQUIPMENT

More
ILSON RADIANT CONVECTOR FURNACES
Lee Wilson ENGINEERING CO., Inc.
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Save Money

CARBURIZED TUBULAR ROLLERS

This one out of
150 has had
11 years service,
saved its cost
10 times.

LONG LIFE, INFREQUENT REPLACEMENT,
LESS POWER, LESS DELAYS, LESS MAN HOURS.

Send for Bulletin 743-19

BADALL ENGINEERING & MANUFACTURING CO.

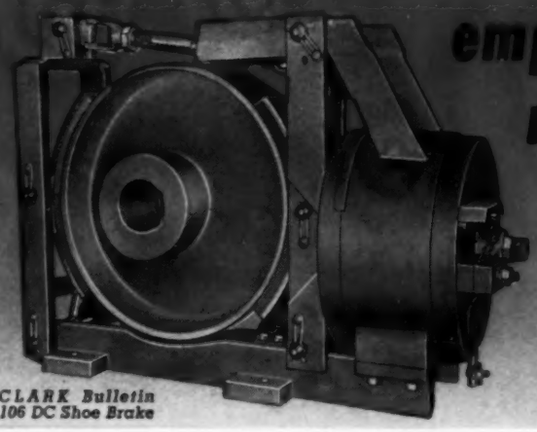
Hammond, Indiana

DID'JA EVER CRACK NUTS?

The basic design of the

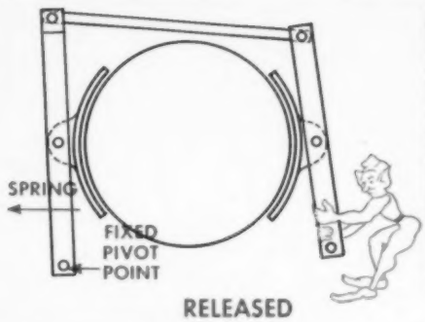
CLARK Bulletin 106 DC SHOE BRAKE

employs the same simple mechanical nutcracker principle—



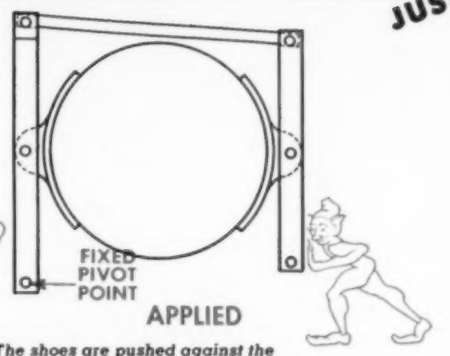
CLARK Bulletin 106 DC Shoe Brake

NO BELL CRANKS
NO OFFSET LEVERS
JUST STRAIGHT LINE LINKAGE



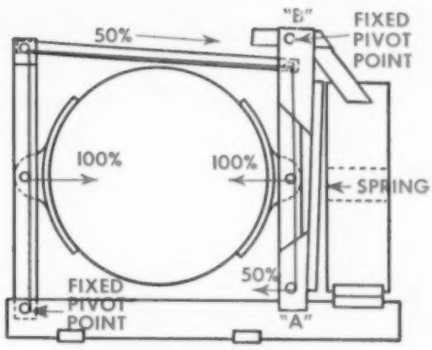
RELEASED

The shoes are pulled away from the wheel by the magnet when it is energized. Proper mechanical linkage spaces both shoes equi-distant from the wheel.



APPLIED

The shoes are pushed against the wheel by the heavy duty main spring when the magnet is de-energized.



BEARING PRESSURE

To produce 100% pressure against each shoe, it is only necessary to exert approximately 50% pressure at point A (sketch at right). This results also in a pull of approximately 50% in the top cross-bar. The reason for these low bearing point pressures is the unique leverage action illustrated. Since the shoes are pivoted near the mid points of each vertical bar, approximately 50% pressure at end points produces 100% pressure at shoe-bearing points. The result of low bearing point pressures is long pin and bushing life, and low maintenance.

Ask for Descriptive Bulletin 106

EVERYTHING UNDER CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152nd STREET, CLEVELAND 10, OHIO

Change to NON-FLUID OIL

From the advent of portable tools, we have made a study of their lubrication—working in cooperation with tool designers and engineers to perfect grades of NON-FLUID OIL that would meet the exacting requirements of different types.

The ability of NON-FLUID OIL to provide dependable, long-lasting lubrication of portable tools is best shown by the fact that NON-FLUID OIL is used for initial loading of tools and is recommended for continued lubrication by practically every leading portable tool manufacturer.

Write for instructive bulletin and free, testing sample of NON-FLUID OIL.

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NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.

NON-FLUID OIL
TRADE MARK REGISTERED

standardize on... PYLETS

A Modern Line of Improved Heavy-Duty Conduit Fittings

PYLET PRACTICAL DESIGN FEATURES

Accurate, malleable iron castings made in Pyle-National's own foundry. Double weather-proof protection—first, galvanized, and then finished with baked sprayed aluminum.

Smooth interiors, round edges and large wiring spaces prevent damage to wires. Ribbed sidewalls provide extra strength.

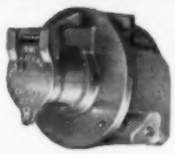
Strong Domed Covers are warped and Body Cover Joints are ground flat for tight gasket seal. Heavy hub sections of ample cross section are tapped straight and true with accurate, cleancut, TAPERED threads.

Dowl-pin type self retaining screws provide easy alignment of covers—hold cover and gasket together during handling.

A Full Range of Types and Sizes for Industrial Wiring

1

2



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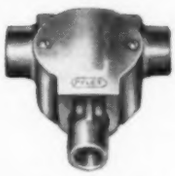

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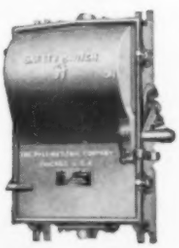

1. FS AND FD PYLETS AND COVERS—1, 2, 3 and 4 gang, square corner types, take all standard switch and receptacle plates.

2. ROUND BASE PYLETS AND COVERS—Ideal for Vaportight junction boxes—Flush and surface mounting. Take standard 4-inch outlet box cover; also vaportight fixtures, plug receptacles and Flexible fixture hangers.

3. VAPORTIGHT LIGHTING FIXTURES—With heavy cast metal bases, weathertight sealing and sturdy guards. Complete line, for 10 to 200 watt lamps, for conduit or wall mounting, universal 4 and 5 hub types, two and three gang, handrail and outlet box types, also midget fixtures.

4. FLEXIBLE FIXTURE HANGER PYLETS—Universal joint hub allows easy removal of fixture, free swing movement of fixture with stop to prevent wire injury, also cushion type for protection against vibration. Also rectangular Pylets with suspension hanger.

5. CAST METAL SAFETY SWITCHES AND CIRCUIT BREAKER PYLETS—Heavy duty safety switches and fuse boxes with or without plug receptacles and circuit breaker Pylets with all features for reliable service under severe conditions. Safety switches have quick make and break, interlocked cover and weathertight gaskets on both cover and hub plates. Available with interlocking plug receptacles.

Refer to your Pylet Catalog 1100 for complete listings including plugs and receptacles—explosion-proof pylets, cord and cable grips—flexible conduit couplings—unions—reducers—elbows and grip handles—portable hand lamps.

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HIBAY*

CHECK THESE HIBAY ADVANTAGES

1. Sturdy Prismatic HIBAY Reflectors for 500 to 1500 watts incandescent; 400 and 1000 watts mercury.
2. An aluminum cover is permanently spun over external prisms using a mastic seal at the joints.
3. Five different prismatic reflectors offer exact lighting pattern required.
4. Lamp focus adjustment allows intermediate settings.
5. Prismatic glass surfaces are impervious to chemical action from fumes or soot.
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7. Tripod holder and ring grip reflector to assure exact positioning of lamp.
8. Outside socket construction favors trouble-free lamp burning.
9. Steel parts plated to resist corrosion.

Send for data sheet giving full optical and mechanical information for the entire line of HIBAY equipment.

*Reg. U. S. Pat. Off.

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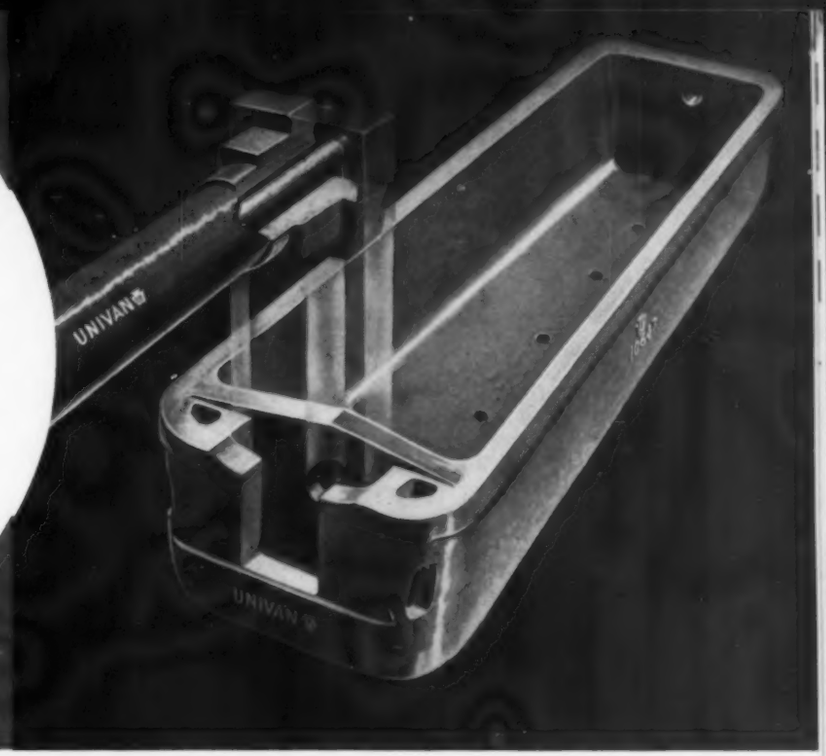
THE HOLOPHANE COMPANY, LTD., THE QUEENSWAY, TORONTO 14, ONTARIO

CHARGING BOXES

make mighty expensive SCRAP!



YOU CAN CUT WAY DOWN ON BREAKAGE AND LOSS WITH

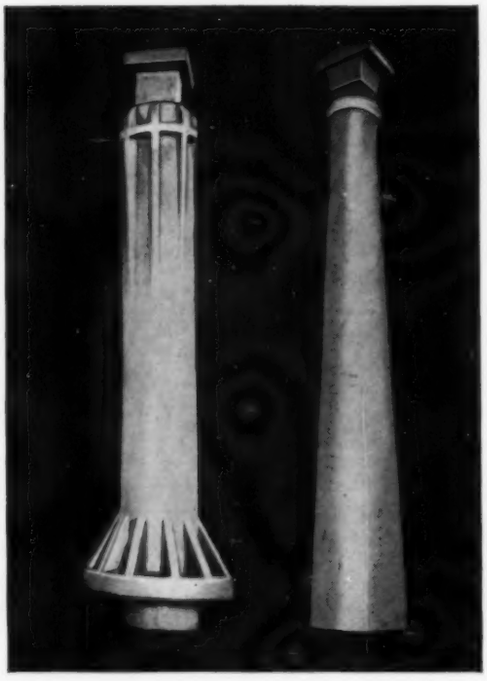
UNION

DOUBLE LIFE HEAD

CHARGING BOXES

Here's why . . . All square corners have been replaced by round ones, insuring a sound casting . . . That specially designed, reinforced head means "double life" without cracking or distortion even with today's higher temperatures . . . Union Boxes are cast from UNIVAN—a special nickel vanadium steel that holds its superior strength under extreme conditions of heat, cold and shock.

Whether you operate with 20, 25, 36 or even 50 cu. ft. capacity charging boxes, we welcome the opportunity to prove that you can do a faster charging job for a longer time at less cost with Union Double Life Head Charging Boxes . . . Your request for further details and prices will receive our immediate attention.



UNION *Alloy Steel* PEELS

Except for the charge itself, no piece of unprotected metal is subjected to greater heat for a longer time than the peel. And, hot or cold, it must withstand severe shock and stresses as well. "Union" has developed for this tough service peels of heat and shock resistant alloys in designs that add months to their useful life . . . Glad to quote from your specifications on either rough or fully machined castings.

"UNIVAN" Trade Mark Reg. U.S. Pat. Off.

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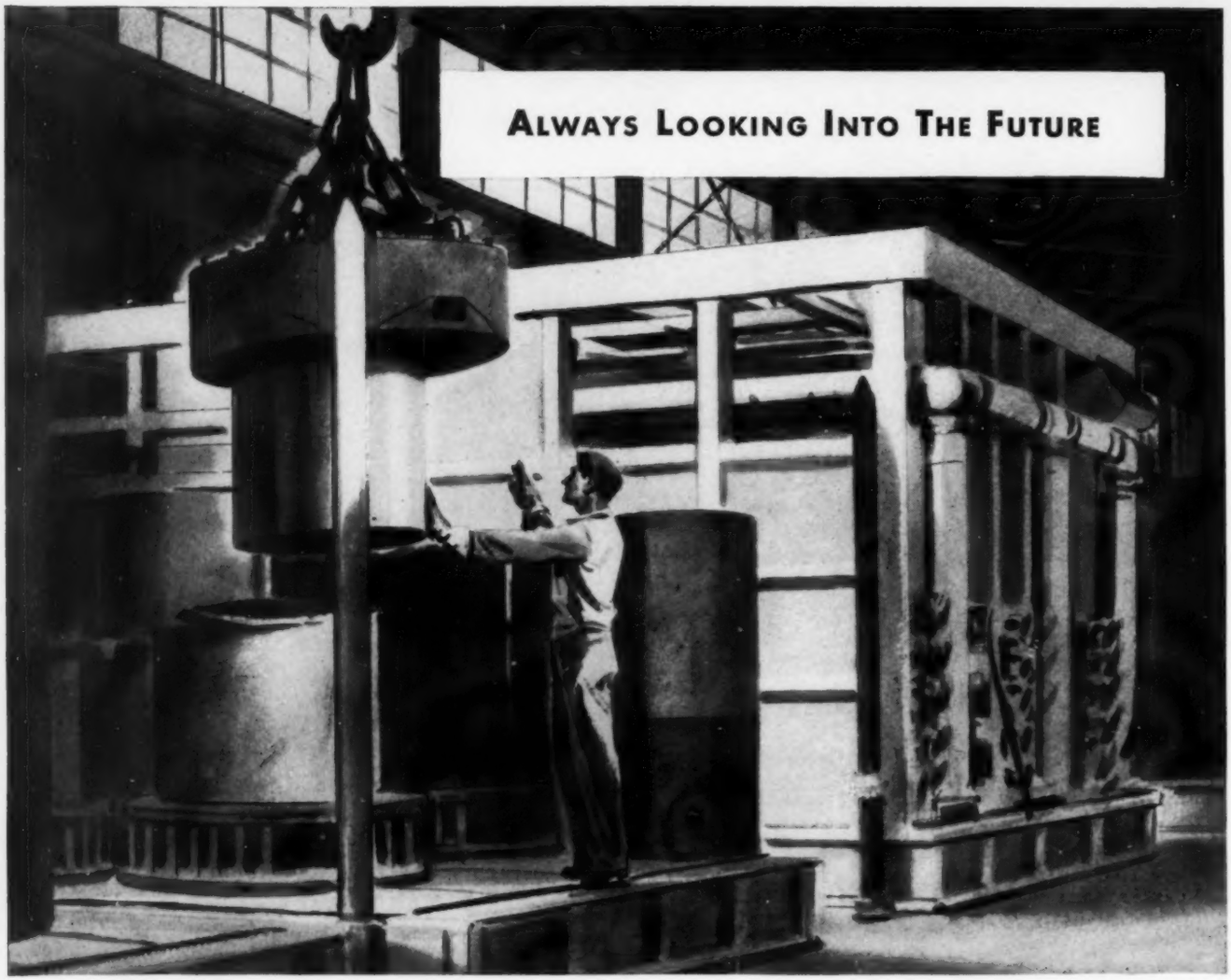
DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

Cinder Pots • Slag Pots • Coupling Boxes • Spindles • Gears • Bells and Hoppers • Ingot Cars • Charging Cars • Annealing Boxes and Bases

UNION HAS COMPLETE MACHINE SHOP FACILITIES . . . ENABLING THE DELIVERY OF ITS PRODUCTS READY FOR USE



Airco is helping find a better way to prepare steel for tin plating

For years, electrolytic tin plating was known to have certain advantages over other methods, but a problem existed in protecting the cold rolled strip from oxidation during furnace annealing prior to plating.

In cooperation with leading steel producers, Air Reduction's research staff is tackling this problem. They are finding that a special mixture of industrial gases, used as a protective atmosphere during annealing, minimizes oxidation. The treated strip retains its polished surface, yielding electrolytic tin plate of superior corrosion resistance.

Air Reduction today is at work on even greater and wider applications of gases for industrial uses. The company's continuing research program is a demonstration of its belief that the business of Air Reduction is the business of America.

If you would like information about any Airco product or process, or if you have a metal working problem, address: Dept. IS-9044, Air Reduction Company, 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas. On West Coast: Air Reduction Pacific Company, San Francisco 4, California.

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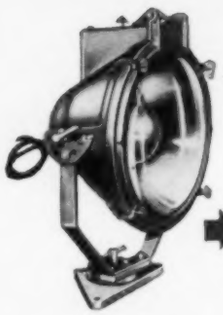
CROUSE-HINDS complete line of *High-Efficiency* FLOODLIGHTS

fill a wide variety of industrial needs

They can help solve YOUR lighting problems



Type LCE-1120 Heavy Duty Floodlight

This powerful 1500-watt floodlight greatly reduces the installation cost, lighting load and maintenance cost where large areas are to be lighted. The cast aluminum alloy housing is corrosion-resisting, and weatherproof. The 20-inch polished *Alzak reflector can be furnished for either a narrow or wide beam. The narrow beam is ideal for very long range projection. Five types of lenses can be furnished. Horizontal and vertical stops facilitate relamping.

Type ADE-16 Heavy Duty Floodlight

This sturdy cast aluminum alloy, 1000-watt floodlight will give you all the advantages of type LCE-1120 but in a smaller size — with a 16-inch polished Alzak reflector. Frequently it will cost much less to project light a considerable distance with Crouse-Hinds long range floodlights than to run cable and install local lighting. There are also indoor locations in large buildings where floodlights are the most economical and satisfactory source of light.

Type MUA Alumalux Floodlight

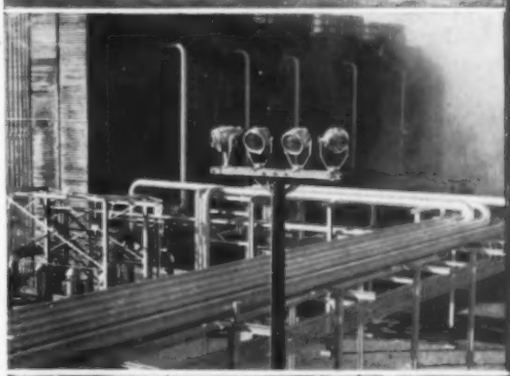
Industrial yards and auto parking lots are most efficiently lighted by the use of floodlights. Crouse-Hinds Type MUA Alumalux 1500-Watt Floodlight provides efficient lighting at mininum first cost. It is widely used for general floodlighting and is ideal for the lighting of athletic fields and playgrounds.

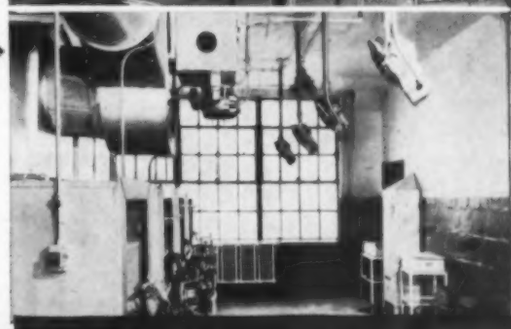
Type RLEE Explosion-Proof Floodlight

This heavy duty explosion-proof and weatherproof 500-watt floodlight has a cast aluminum alloy housing. It is designed for service in locations that are hazardous because of the presence of explosive atmospheres containing gasoline, naptha, petroleum, benzol, alcohols, acetone, lacquer solvent vapors, and natural gas. It can be furnished with either a wide or narrow beam 13-inch Alzak aluminum reflector.

Type RCDE-8 Explosion-Proof Floodlight

This is an explosion-proof floodlight in a 200-watt size, with an 8-inch reflector, either wide or narrow beam. It can be furnished for suspension mounting, standard base mounting, or as a portable floodlight with a handle and wheel base.





*Alzak is the registered trade mark of the Aluminum Company of America

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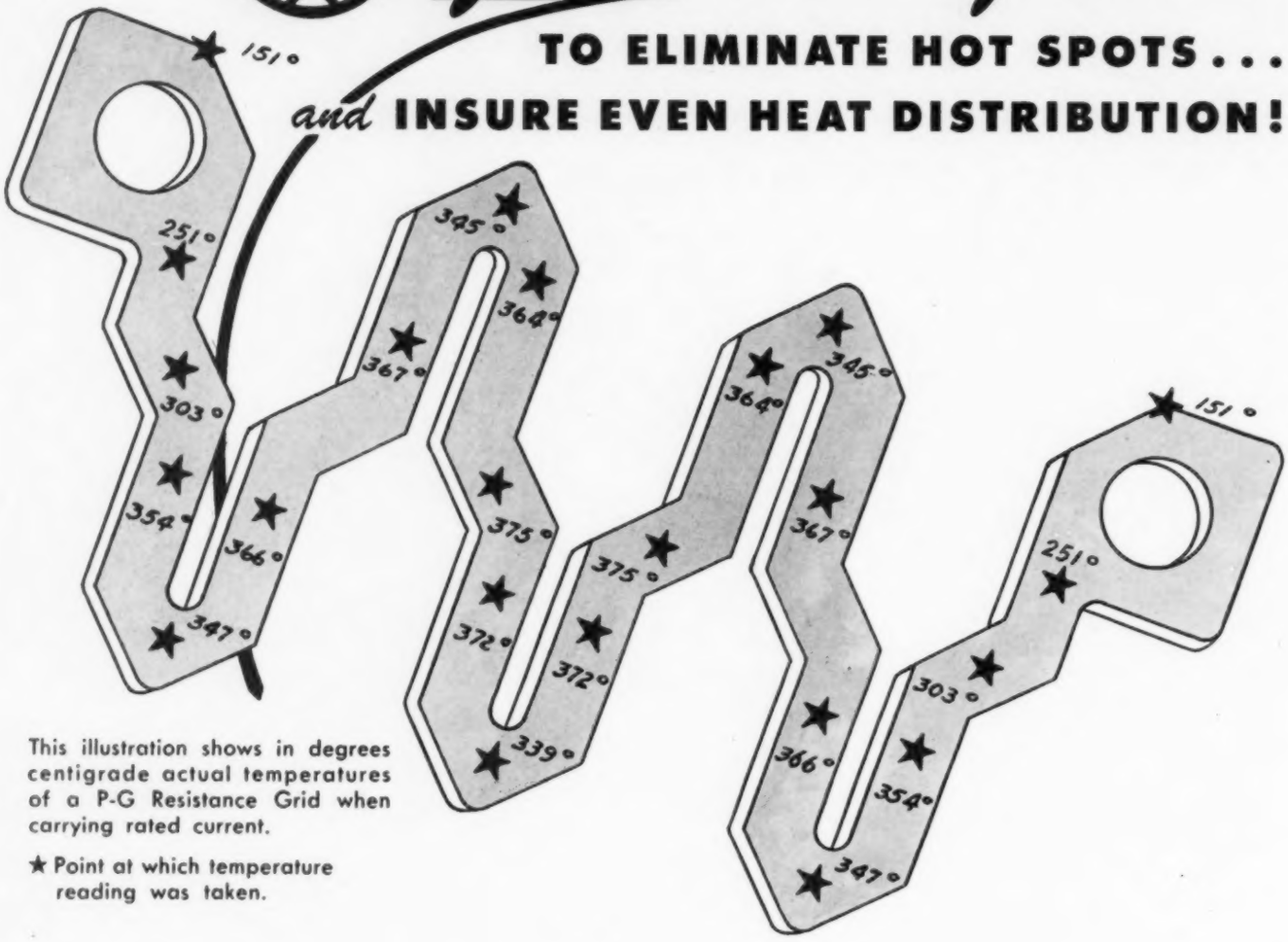
P-G *Grid Designed*

TO ELIMINATE HOT SPOTS . . . *and* INSURE EVEN HEAT DISTRIBUTION!



This illustration shows in degrees centigrade actual temperatures of a P-G Resistance Grid when carrying rated current.

★ Point at which temperature reading was taken.

P-G *Steel Grid Resistors* **HAVE DEMONSTRATED THIS FOR MANY YEARS!** Laboratory tests of temperature distribution on "Type T2 Resistance Grids" at rated current indicate extremely uniform temperatures over the working surface. In fact, the extreme variation is held to approximately 20°C. Note also, that temperatures at points of contact are much cooler than at any other point on the entire grid. You, too, can obtain these results by specifying P-G for your next application.

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

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Heavy Nose, Super-Cooled Bosh Plates—for the Tuyere Zone where plates are most apt to burn.

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Cinder Notches - Notch Coolers
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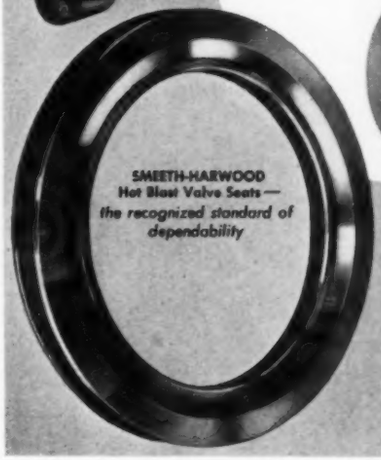
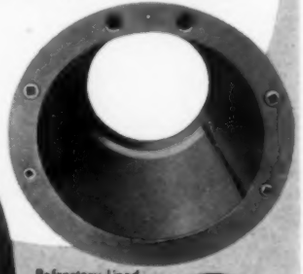
Cinder Notch



SMEETH-HARWOOD Hot Blast Valve Seats—*the recognized standard of dependability*



Refractory Lined Safety Coolers

Steudel Tuyere *shaped to eliminate cutting underside of nose*

Steel Mill Switches Fuels as Much as 10 Times a Day

Yet Their

HAUCK *Combination* Oil and Gas BURNERS

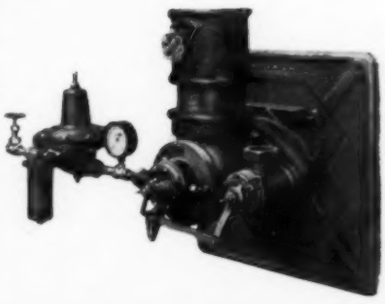
ALWAYS REMAIN EQUALLY EFFICIENT

When the supply of natural gas runs low, then switch to oil and run just as smoothly until a new gas supply is available, changing from one fuel to the other as necessary.

Once burners are adjusted for burning either oil or gas, the change from oil to gas or vice versa can be made quickly by merely closing one fuel shut-off valve and opening the other, without piping changes.

One control lever regulates and proportions the flow of air through the burner and at the same time the flow of oil or gas, or both fuels when so adjusted.

These burners are easy to install and operate on any furnace. They really meet the emergency of today's fuel pinch.



Combination Proportioning Oil and Gas Burner for Automatic Control get Catalog 407S

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PITTSBURGH-ERIC PROCESS

Lectumen

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FOR WATER MAINS 3" to 24" I.D.

Samples of pipe before and after cleaning and lining by Pittsburgh-Eric Process.

17,100 ft.—24 in. MAIN WATER DEPARTMENT, CITY OF CHARLOTTE, N.C.

Before Cleaning "C"—69
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After Coating "C"—130

G.P.D. Before Cleaning—5.6 M.G.D.
G.P.D. After Coating—10.4 M.G.D.
4.8 M.G.D.—*INCREASE*

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If it's power piping equipment it's in the CRANE line

Valves, fittings, piping accessories, and fabricated pipe—the Crane line includes them all! In steel, iron, brass, or alloy materials, Crane gives you the most comprehensive selection in all types of equipment for power, process, or general utility piping.

ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

This high pressure steam system, for example, shows how the Crane line makes easier work of specifying and ordering. One catalog puts everything at your finger tips. One order to your Crane Branch or Wholesaler covers all the equipment you need. Undivided responsibility for materials helps you get a better installation—on schedule! The high quality of all products from Crane means uniform dependability throughout the installation.

Your local Crane Branch is well-stocked to help you get these important piping advantages.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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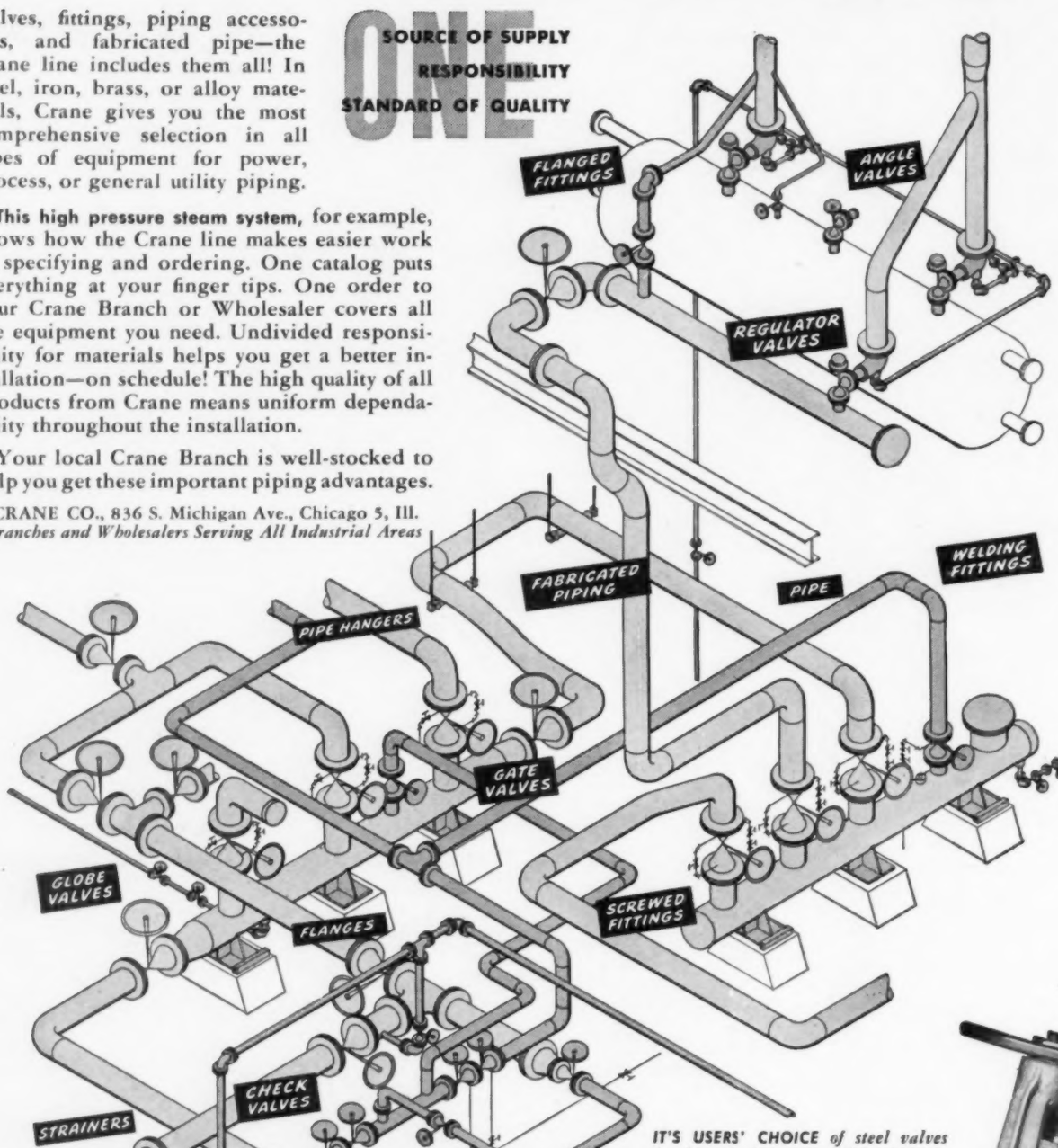

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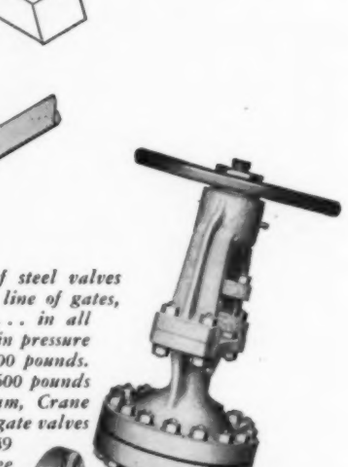

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Bird's-eye view of the heavy precision shaft and bearing assembly. Note the gas-tight stuffing box also subjected to the pressure test.

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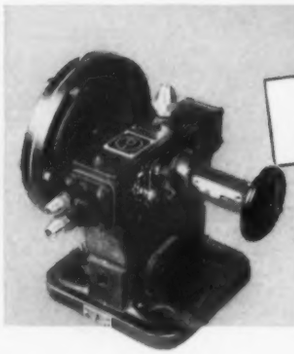
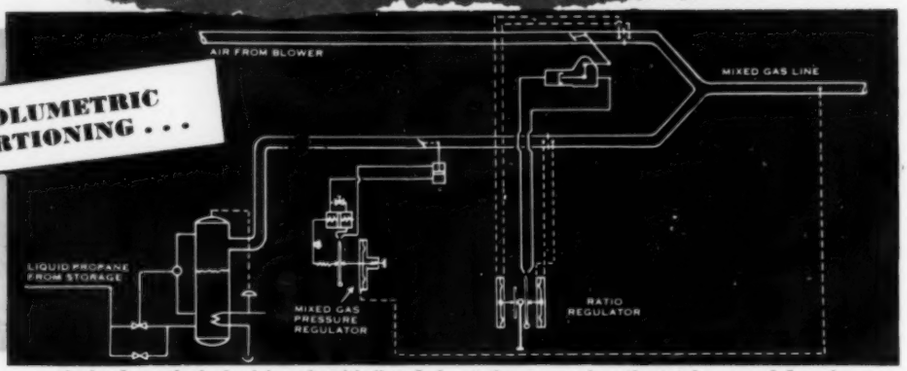


ASKANIA
PRESSURE-FLOW REGULATOR

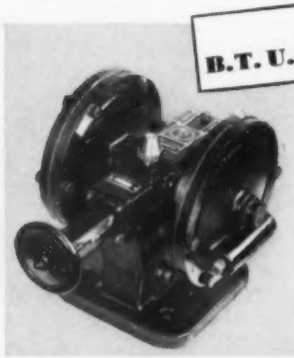
BY VOLUMETRIC PROPORTIONING . . .



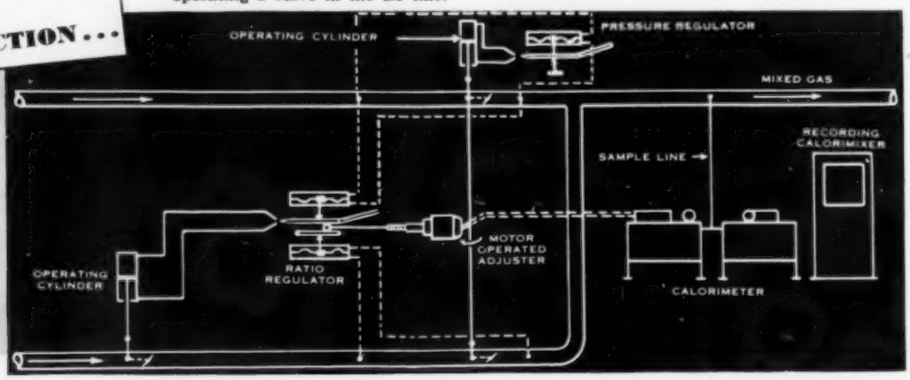
A simple method of mixing air with liquefied petroleum gas when the total range of flow does not exceed 1 to 10, and where volumetric proportioning produces a gas mixture with a sufficiently constant BTU value.

A standard Askania Pressure (or Flow) Regulator delivers gas to the mixing station in accordance with the demands for gas. Both gas and air flow are measured by orifices and a standard Askania Ratio Regulator maintains the flow through the air orifice in exact proportion to the gas flow. Ratio of flow is maintained by automatically operating a valve in the air line.

WITH B.T.U. CORRECTION . . .



ASKANIA RATIO REGULATOR

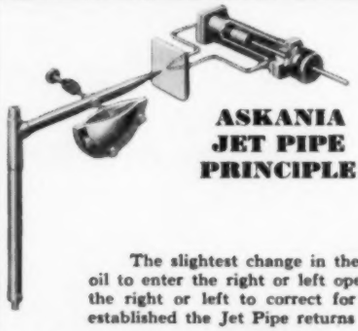


A method of handling flow ranges of more than 1 to 10. Instead of using fixed orifices as in the case of simple volumetric proportioning, the Askania Pressure Regulator changes the area of both the air and gas orifices, (which in this case are valves) operating them in parallel.

The Askania Ratio Regulator maintains a differential pressure across the gas orifice in direct ratio to the differential pressure existing across the air orifice. A Cutler-Hammer calorimeter is constantly measuring the BTU value of the mixed gas and adjusting the ratio regulator in accordance with the BTU changes.

Askania Regulators for pressure, flow and proportioning are ideally suited for gas mixing control. Operated by the sensitive Jet Pipe, Askania Regulators provide efficient, automatic control for simple volumetric proportioning or for the Askania-Cutler Hammer method in which corrections for pressure, temperature, humidity and gas heating values are made for extreme accuracy.

When you are considering the advantages of gas mixing to provide a stand-by, substitute or "peak-shaving" fuel, get the facts on Askania controls. Full details available.



ASKANIA JET PIPE PRINCIPLE

The Askania Jet Pipe converts the most delicate pressures or signals from the source of measurement into rate of movement of a hydraulic cylinder. It consists of the Jet Pipe swinging freely on a hollow vertical pivot into which oil is pumped at high pressure. As the oil stream leaves the nozzle of the Jet Pipe it strikes at two closely adjacent distributor openings. The openings are piped to both ends of the cylinder which is connected to valve, damper or other type controller.

The slightest change in the signal moves the Jet Pipe, causing more or less oil to enter the right or left opening. This causes the cylinder to move either to the right or left to correct for the signal variation. As soon as equilibrium is established the Jet Pipe returns to its median position.

Send for bulletin 135 . . . completely describing and illustrating Askania gas mixing methods and controls.

ASKANIA Controls

ASKANIA REGULATOR COMPANY

A subsidiary of General Precision Equipment Corporation

240 East Ontario St., Chicago 11, Ill.

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SAFETY DESIGN of the Bonnot Billeteer has brought a new standard of safety to billet-sheds.

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Bonnot engineers will be pleased to give you further information about this machine. Write today!

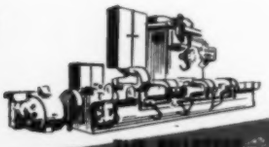

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Photo by courtesy of James Graham Mfg. Co., Newark, Calif., manufacturer of Wedgewood ranges.

Each SPEEDAIRE unit saved $243

THE Speedaire shown here is operating a pebble mill, grinding enamel for use in the manufacture of kitchen ranges—one of two such installations at this plant.

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For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3278 East 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

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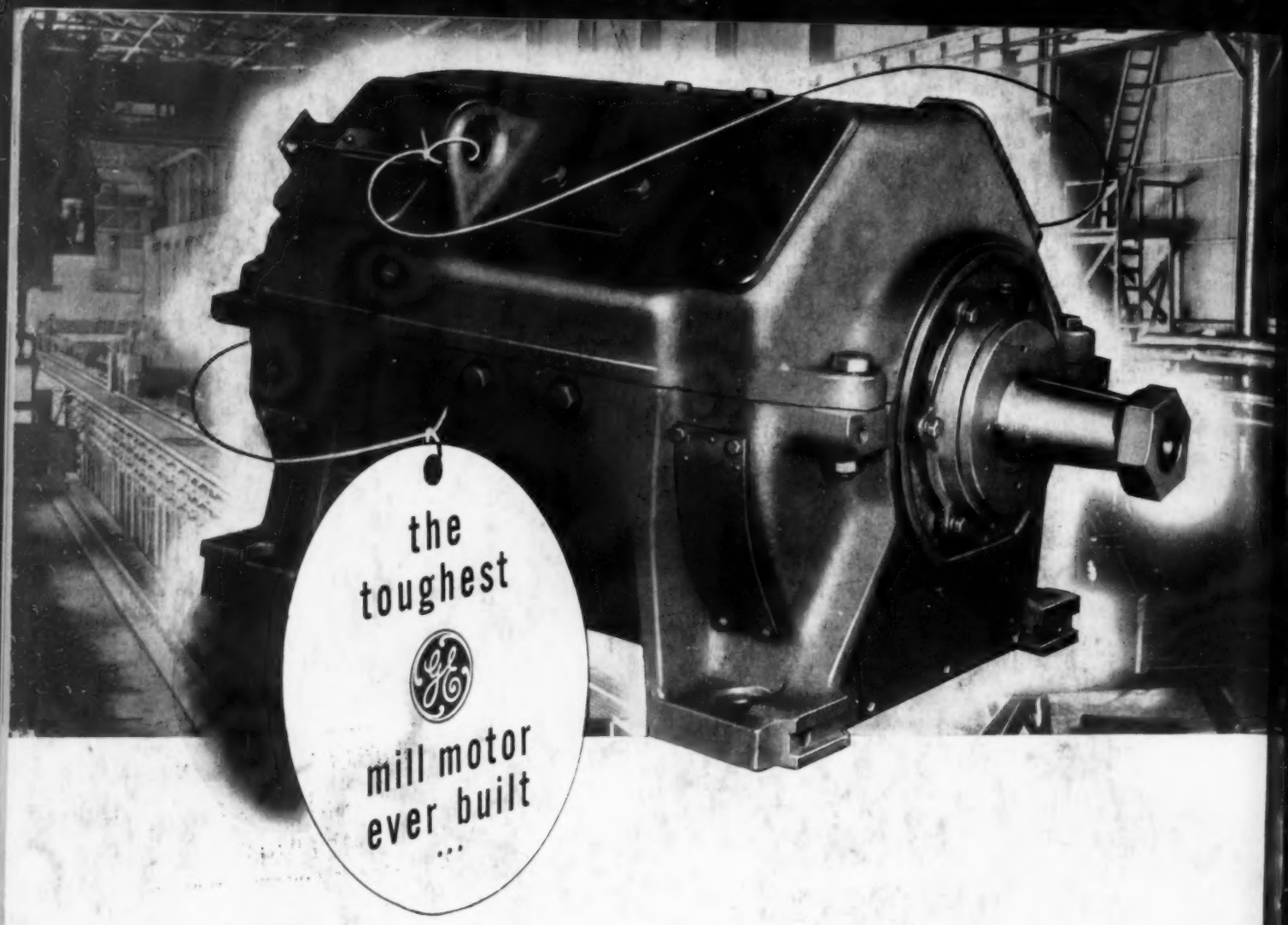
Speed Reducers



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MD-600 MILL MOTORS

GENERAL ELECTRIC

659-47